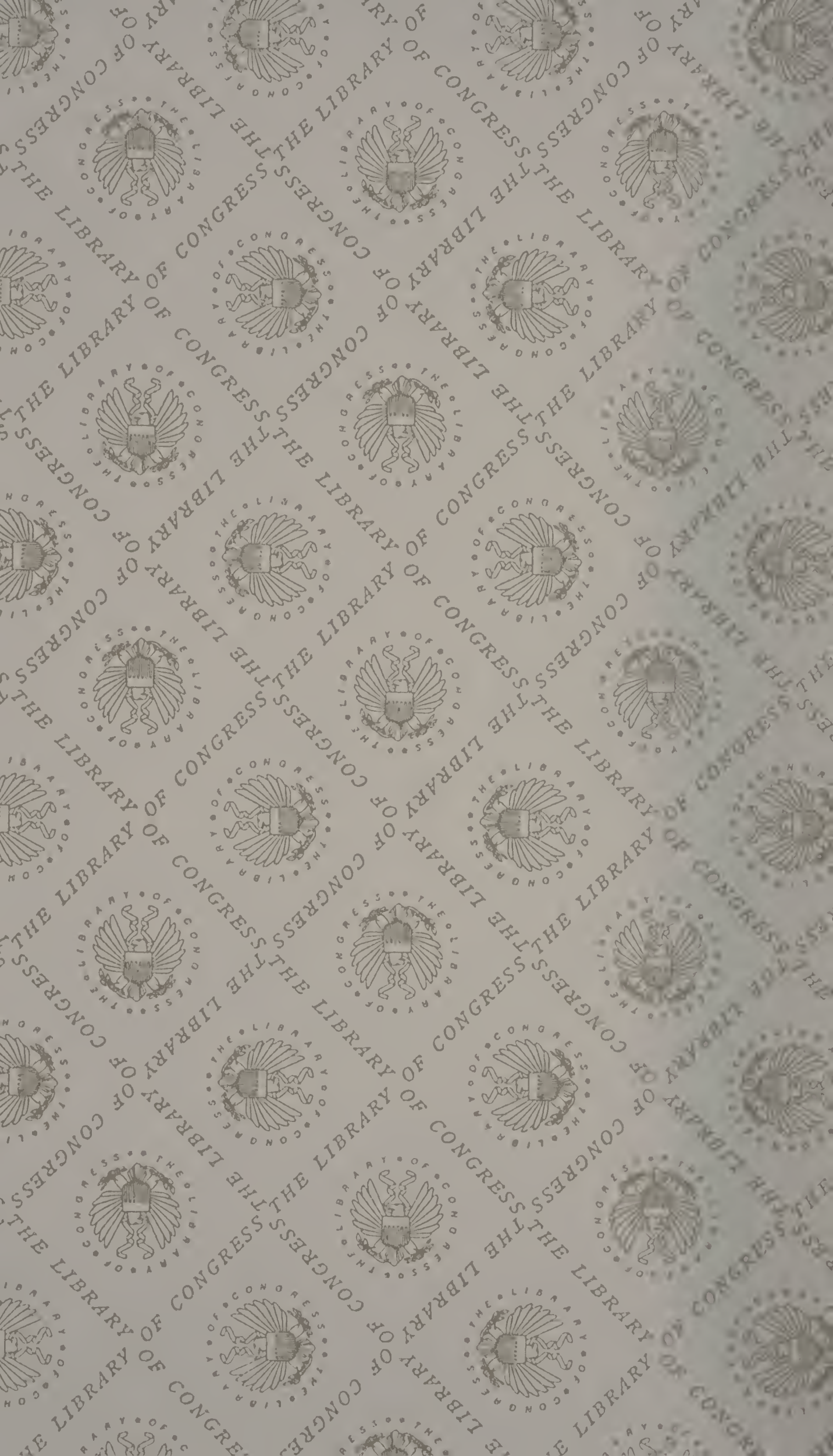


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No.....

# DAIRY HUSBANDRY

## LABORATORY MANUAL FOR ELEMENTARY DAIRY HUSBANDRY COURSES

2nd Edition

Revised

L. C. THOMSEN



# DAIRY HUSBANDRY

## LABORATORY MANUAL FOR ELEMENTARY DAIRY HUSBANDRY COURSES

BY

L. C. THOMSEN

DAIRY DEPARTMENT

UNIVERSITY OF WISCONSIN

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2d Edition, revised

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# INTRODUCTION

The exercises listed in this manual are designed for introductory courses in Dairy Manufacturing. A sufficient number of exercises is included to cover eight semester hours (four-fifths) of laboratory work. It is, however, best adapted to a course of four or six semester hours (two or three-fifths) of laboratory work, since it will then permit a wide choice of exercises, according to the type and ability of the student. In case of the bright or fast working student additional exercises may be assigned. A number of so-called elementary exercises have been omitted from this manual, because their inclusion would be impractical. In some instances this was done because the apparatus and material necessary would be too expensive, in others it was merely a matter of choosing the simpler and shorter method.

It is not the purpose to have this manual serve as a text book, but it should act as a guide or aid in the study of the text. The manual suggests the plan of the work, but for detailed instructions on the operation, the text should be used. At the foot of most exercises are given specific references to text books most commonly used for a course of this kind. Supplementary references to books pertaining to dairying, found in agricultural libraries, are also included where they seem particularly pertinent.

The manual is divided into two parts, each of which in turn is divided into series of exercises. Part I deals with the analysis of dairy products. Part II takes up the home manufacture of several common dairy products. Any or all of the exercises of a series may be given for class work.

Preceding Series I part I is given a list of material that may be checked out to each student at the opening of the course or at intervals throughout the course as needed. The list is sufficient for a class of ten students. Preceding every other series is given a list of additional material necessary. A \* precedes those items used for but one exercise in the series.

**Attendance:** Each student is expected to attend regularly at the opening of the laboratory period and to remain in attendance until the close of the period. If his experiment has been completed long before the period ends, he should report to the instructor for additional work. An excellent plan from the viewpoint of both student and instructor is the initialling by the instructor of the observations recorded in the manual by the student. This serves as a check on the laboratory attendance, and also informs the student that the exercise is ready for final transcription. The instructor will meet the class as a whole in one of the lecture rooms immediately preceding the laboratory period. At this time he will give any additional instructions or assignments that he deems necessary.

Absences must be made up by arrangement with the instructor within a reasonable time of their occurrence, usually two weeks. In cases of illness, for which a medical excuse has been presented, this time may be extended.

While in the laboratory the student should conduct himself as a dairyman and student. The prime requisite of a dairyman is cleanliness, and a student is not expected to leave the laboratory until it is in satisfactory condition.

**Lecture Notes:** Lecture notes should be written up in such manner that the note book is presentable at any time it may be called for. Each day's lecture should be begun on a new page, and should bear a date. The above does not refer to instructions given preceding the laboratory period. If the instructor so desires he may call for the manual and laboratory notes at any time.

**Reports:** The regular reports should be made on 8x11 paper and handed in at the period following the performance of the experiment, unless other arrangements are made by the instructor. The reports should be written with ink or typewritten and should be in the form outlined below:

1. Number of experiment; name and number of student.
2. Object: As given in the manual.
3. Procedure: Apparatus used; a brief description.
4. Observation: Filled in and copied in exercise as outlined in the manual.
5. Questions: The question should be copied, and it should be followed by a comprehensive, but concise answer. Additional questions may be given by the instructor.

A two-inch margin should be left on the left hand side of the page for notations by the instructor. Corrections should be made as requested and the exercise should again be handed in for credit.

Materials supplied by the student:

- (1) Text book
- (2) Laboratory Manual
- (3) An acid-proof apron or a pair of overalls
- (4) Dividers
- (5) Grease pencil to write on glass
- (6) Note book, loose leaf, 8x11

L. C. THOMSEN.

#### Abbreviations:

- F. & W.—Farrington and Woll—Testing milk and its products (1924).  
Van S.—L. L. Van Slyke—Modern methods of testing milk and milk products (1912).  
St.—W. A. Stocking—Manual of milk products (1917).  
Jud.—H. F. Judkins—Principals of dairying (1924).

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#### Introduction to second revised edition

Since the publication of the first edition of this Manual, it has been found advisable to make a number of minor changes so that the exercises might be of a greater general interest. It has also been deemed advisable to drop several little used exercises and replace them with exercises pertaining to more recently developed dairy tests. It was also thought advisable to enlarge the appendix by the addition of a number of tables of general interest to the student of dairying.—L. C. T.

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# PART ONE—ANALYSIS

## SERIES A.

**Cleaning glassware, determining the accuracy of glassware, proper speed of tester, strength of acid.**

**Materials:** Since these are in fact preliminary exercises, the material required is the same as is necessary for the ordinary Babcock milk testing process. The unstarred items of the list given may therefore act as a guide for material to be checked out to each student.

(Material for 10 students)—

40—10% Babcock milk test bottles.

20—30% 6", 9 or 18 gr. Babcock cream test bottles.

10—17.6 cc. pipettes.

10—17.5 cc. acid cylinders.

10—1 pint fruit jars or 1 pint milk bottles.

10—1 quart enameled cups.

10—Test bottle brushes.

10—25 cc. or 50 cc. Burettes.

10—8.8 cc. pipettes.

10— $\frac{1}{2}$  pt. white cups.

10—Aluminum Beakers (125cc.).

10—100 cc. cylinders.

10—Lactometer cylinders.

10—Quevene Lactometers.

5—gallons Sulfuric acid.

5—Balances (Torsion moisture type).

2—Enclosed Babcock testers (power or hand).

10—Pounds washing powder.

5—Thermometers (Pasteurizing).

5—9 gr. weights.

5—18 gr. weights.

5—10 gr. weights.

\*10—10% Trowbridge calibrators.

\*10—30% Trowbridge calibrators.

\*2—Speed indicators.

\* 2—Quarts cleaning solution (4 oz. potassium di-chromate crystals and 2 quarts  $H_2SO_4$ ).

\* 2—Acid hydrometers.

\* 2—Westphal balances.

\*80—Strips blotting paper ( $\frac{1}{4}$ "x5").

\* 1—Pound paraffin.

\* $\frac{1}{2}$ —Pint etching solution (67 gr. of 48% Hydrofluoric acid and 28 gr. of C P Ammonium Fluoride) to be kept in a wax, paraffined or rubberized container.

\* 1—Lead dish (100 cc.).

\* 1—Cover glass.

\*1—File.

\*50 gr.—Calcium Fluoride ( $Ca F_2$ ).

**EXERCISE NO. 1.**

**Object:** *To properly clean laboratory equipment.*

**Procedure:** One of the most important, yet often neglected parts of the laboratory work of a dairy manufacturing plant, is the cleaning of glassware. Dirty glassware not only indicates slovenliness, but it is also conducive to inaccuracies in the work. If the glassware is properly cleaned immediately after use, it is very easy to keep clean.

- A.** Bottles containing acid or milk should be shaken well when emptied so as to remove sediment and then rinsed out in clean, warm water, and filled with soap suds by submerging. With bottles about two-thirds full of soap suds, shake vigorously. Empty the bottles of the soap solution and rinse in clear warm water. Place aside to drain. Ordinarily the above procedure will maintain the glassware in a clean condition.
- B.** If the treatment under **A** does not remove the scale on the inside of the bottle, pour into the bottle about 5 cubic centimeters of the prepared cleaning solution and be sure it comes in contact with the scaled surfaces. Set the bottle aside for several minutes, and shake occasionally. Drain this solution from the bottles and proceed as under **A** above.

Note: The cleanliness of Babcock glassware may be checked by running a blank test with clean water and sulfuric acid, using the same proportions as in the milk test (See exercise 6).

**Observations:**

**Conclusions:**

- Questions:** (1) If no cleaning solution is available what other methods can be suggested for removing scale from the inside of the bottle?
- (2) Enumerate several conveniences for use in washing glassware.
- (3) What is the average specific gravity of cow's milk?
- (4) What is the weight of a charge of milk delivered by a 17.6 cc. pipette? Show by use of figures.

**References:** F. & W. ¶ 46, 47, 48; Van S. pp. 53-55, 175-176; Jud. 70-71.

**EXERCISE NO. 2**

**Object:** *To determine the accuracy of the glassware used for making the Babcock test.*

**Procedure:** Some state laws specify that only tested glassware is to be used for making the Babcock test. There are several methods used for determining the accuracy of the glassware. Each test bottle should be tested by at least two of the methods suggested.

- A. Calibrate each of the 10% milk test bottles with the proper Trowbridge calibrator, and do likewise with the 30% cream test bottles. Record results for the half, and for the whole scale. Particular care should be taken to have the neck of the bottles dry. Blotting paper is provided. Avoid air bubbles.
- B. Determine the accuracy of each bottle at the half and the whole scale by using an accurately graduated burette. Observe the same precautions as for A.
- C. Determine the accuracy of the whole scale by balancing the bottle when filled to the zero mark with distilled water, and weighing again when filled to the highest graduation.
- D. Measure the length of the scale of each of the bottles and record as millimeters.
- E. The pipette may be calibrated by weighing a small, clean, dry beaker and emptying the pipette which has been filled to the 17.6 cc. mark with distilled water at 20° C. (68° F.) into the beaker. The last few drops may be expelled from the pipette by closing the top with a finger, while the bulb is being warmed with the hand. Weigh the beaker with the water. The pipette should deliver 17.6 grams of water.
- F. Another method for determining the accuracy of the pipette is to empty it when filled to the 17.6 cc. mark into a graduated burette which has been emptied to the 20 cc. mark. The pipette should deliver nearly 17.6 cc. of water.
- G. The acid cylinder, for information only, should be calibrated by using the burette.

See F. & W. ¶ 307 for complete specifications of bottles and pipettes.

**Conclusions:**

**Questions:** (1) Describe in detail the calibration of test bottles with mercury.

- (2) What is the capacity in cc. of the neck of an 8% milk test bottle? A 10% bottle? A 30% cream test bottle? What is the weight of a volume of butter fat at 140° F. in each of the above bottles when it just fills the neck from 0 to the highest graduation?
- (3) Why is the neck of a test bottle constructed so that the volume represented by one per cent is equal to .2 cc?
- (4) What are the legal requirements for Babcock glassware in this state?

**References:** F. & W. ¶ 44, 44a, 48, 49, 50, 53-63, inclusive. Van S. pp. 46-53; Jud. pp. 64-66; St. pp. 105-109.

**EXERCISE NO. 3**

**Object:** *To determine the proper speed of the Babcock centrifuges*

**Procedure:** Dr. Babcock, in his early work with the tester, found that with a diameter of 18", the optimum separation was obtained at a speed of 700–800 R. P. M. This gives a centrifugal force of approximately 30.65 pounds. (F. & W. ¶ 66.

- A. If 800 R. P. M. is used as the correct figure for an 18-inch tester, then the speed of any other tester can be calculated by using the formula.

$$\text{R. P. M.} = \sqrt{\frac{9 \times 800^2}{r}} = \text{radius of tester studied.}$$

- B. With a speed indicator determine the steam pressure necessary to operate the tester when empty, when half filled, and when full.

Note. In obtaining the diameter of a tester, it should be measured with the cups extended.

**Observations:**

| Tester | Diameter | Speed | lbs. pressure<br>empty | lbs. pressure<br>½ full | lbs. pressure<br>full |
|--------|----------|-------|------------------------|-------------------------|-----------------------|
| 1      |          |       |                        |                         |                       |
| 2      |          |       |                        |                         |                       |
| 3      |          |       |                        |                         |                       |

**Conclusions:**

**Questions:** (1) Give the table of speeds for testers having a diameter of from 10–24 inches, progressing by 2.

- (2) Describe a method for determining the necessary speed of testers when no speed indicators or formulas are available.

- (3) What advantages are claimed for a steam tester over a belt, water motor, or hand power tester.

- (4) Give the average composition of normal cow's milk.

**References:** F. & W. ¶ 15–22, inclusive; 64–71, inclusive; Van S. p. 15, 38–43; Jud. 69; St. 16–20.

**EXERCISE NO. 4**

**Object:** *To determine the strength of the sulfuric acid used for the Babcock test.*

**Procedure:** Sulfuric acid for the Babcock test should have a specific gravity of 1.82–1.83 or should be 90–92% pure.

- A. The specific gravity may be determined by using the Westphal balance as follows: The balance should be leveled carefully. The screw on the beam should be adjusted so that it balances exactly with the plunger suspended in the air. The glass cylinder should be filled with acid at 15° C. (59° F.) and placed so that the plunger will just be submerged. Proper weights are thus placed on the beam until it again balances. Take the reading.
- B. Place acid at a temperature of 15° C. (59° F.) in a tall glass cylinder and insert acid hydrometer. Read the specific gravity direct.

Note: Great care should be taken to avoid having acid come in contact with metal or wood.

**Observations:**

| Sample | Temperature | Sp. gr.<br>Westphal | Sp. gr.<br>Hydrometer |
|--------|-------------|---------------------|-----------------------|
| 1      |             |                     |                       |
| 2      |             |                     |                       |

**Conclusions:**

- Questions:** (1) What effect has temperature on the specific gravity of sulfuric acid?
- (2) What happens if a bottle of sulphuric acid remains unstoppered?
- (3) Give 3 reasons why sulfuric acid is used when making a Babcock test for fat in milk.
- (4) Describe another method of determining the specific gravity of sulphuric acid.

**References:** F. & W. ¶ 72–78, inclusive; Van S. pp. 43–46; Jud. 62; St. P. 115.

**EXERCISE NO. 5**

**Object:** *To become acquainted with methods of etching and labeling glassware.*

**Procedure:** All newer glassware has a space provided on the bulb for writing. However, it is sometimes desired to etch numbers on glassware or to produce roughened surfaces for writing. This may be done as follows:

The student should familiarize himself with at least two methods.

- A. Take a piece of paper of the desired shape and stick it on the bottle over the spot to be etched. Immerse the bottle in hot paraffin. Remove the paper by cutting the paraffin around it. Place etching solution on the exposed surface for 20 seconds to 1 minute. Wash off the solution and try to write on the surface. If unsatisfactory, repeat the treatment. A number may be etched on the bottle by merely scratching the number through the paraffin.
- B. Prepare surface to be etched as indicated under "A" above. Place some calcium Fluoride in a lead dish. Add enough sulfuric acid to form a paste. Allow the fumes to come in contact with the exposed glass surface, or spread a small quantity of the paste over the exposed surfaces.

Note: Whenever hydrofluoric acid is produced, the process should be carried on under a hood or at an open window.

- C. A rough surface may be produced on glass by using a fine steel file, dipped in water, and passed over the surface to be roughened, several times.
- D. There are two commonly used methods for protecting labels on reagent bottles:
  - (1) Use a good mucilaged label and on it write the desired information with India ink. Place the label on a previously cleaned surface of the bottle, and when dry, paint the labeled part entirely with very hot paraffin, or dip the labelled part in paraffin.
  - (2) Proceed as under "1" above, but cover the labelled area with shellac.

**Observation:** Record time required for the solution to act.

**Conclusion:**

**Questions:** (1) Give a definition for legal milk in this state.

- (2) Of what is the ash of milk composed?
- (3) What is meant by the term vitamins, and state briefly how milk compares with other foods in vitamin content.
- (4) What is colostrum milk? How does it differ from normal milk?

**References:** F. & W. ¶ 20, 23; Van S. pp. 1-19; Jud. pp. 22-28; St. pp. 28-29; 37-38.

## SERIES B

## Testing Milk for Fat

**Materials** necessary for 10 students:

- \* 1—Pint *Sin-acid* solution.
- \* 4—Ounces caustic soda or caustic potash, or washing powder.
- \*  $\frac{1}{2}$ —Gallon *Ethyl ether*.
- \*  $\frac{1}{2}$ —Gallon *Petroleum ether*.
- \* 1—Pint 95% *Eth · alcohol*.
- \* 1—Pint *aqua ammonia*.
- \*  $\frac{1}{2}$ —gallon *distilled water*.
- \* 10—*Rohrig* extraction tubes (*Röse-Gottlieb* test).
- \* 1—Hood.
- \* 1—Hot plate.
- 1—Hot water bath.
- \* 1—Sensitive balance.

## EXERCISE NO. 6

**Object:** To become acquainted with the operation of the *Babcock* test.

**Procedure:** A demonstration of the important steps in the test will be given by the instructor, preceding the laboratory period. In order that the main points may be fixed in mind, they are given below in the order of perform i.ee.

- A. (1) Procure a *representative* sample of milk (about 100 cc.) and *mix* thoroughly by pouring back and forth from one container to another at least six or more times, depending of course, on the condition of the sample.
- (2) Immediately after mixing, transfer 17.6 cc. of the sample to a 10% milk test bottle. Blow the last few drops from the pipette.
- (3) Measure out 17.5 cc. of acid and pour into the bottle so that it runs down the side of the neck and rinses off adhering milk.
- (4) Mix the milk and acid thoroughly by giving the bottle a rotary motion. *Mixing* cannot be overdone.
- (5) Whirl the bottles in the centrifuge for five minutes at a speed which will produce 30.65 pounds pressure per square inch on the bottom of the bottle. Bottles should be placed so that the tester is balanced. (See Ex. 3, Series A.)
- (6) Add hot water (at least 140° F.) up to the neck of the bottle and whirl two minutes.
- (7) Add enough hot water (at least 140° F.) to bring the fat column between the 0 and 10% marks, and whirl one more minute.
- (8) If a steam turbine tester is used, remove bottles from tester and with a pair of dividers read the entire fat column (including the lower and upper menisci). If the temperature of the fat column is not within the 120°-140° F. limits, a hot water bath deep enough to permit the fat column to be submerged, should be used for four minutes. If dividers are not at hand, the per

cent of fat may be obtained by subtracting the reading obtained at the base of the fat column from the reading obtained at the top of fat column.

Note: (1) Since sulfuric acid is very corrosive, great care should be exercised when handling it.

(2) Acid bottles should be kept stoppered when not in use.

(3) The enclosed type of testers are preferable and they should be kept closed when operated.

**Observations:** Record results as follows:

| Sample | % fat | Color of fat | Condition of fat | Condition of acid mixture |
|--------|-------|--------------|------------------|---------------------------|
| 1      |       |              |                  |                           |
| 2      |       |              |                  |                           |
| 3      |       |              |                  |                           |

**Conclusion:**

**Questions:** (1) Describe how a sample of frozen milk should be obtained for the Babcock test.

(2) Why are bottles filled twice with hot water and whirled three times rather than filling once and whirling once?

(3) When should a water bath at 120°-140° F. be used when testing? Why?

(4) Why is the acid poured in such a manner that it runs down the side of the bottle under the milk, and not directly into the milk?

**References:** F. & W. ¶ 29-42, inclusive, 66; Van S. p 23, 57-70; Jud. pp. 41-75; St. pp. 112-119.

**EXERCISE NO. 7**

**Object:** *To study the effect of weak acid on results obtained by the Babcock test.*

**Procedure:** "It is indeed remarkable what slight difference in the specific gravity of the acid will make themselves apparent in the working of the test." (F. & W. ¶ 75.)

A. Make each of the following tests in duplicate:

- (1) 17.6 cc. of milk and 17.5 cc. of acid (sp. gr. 1.82-1.83).
- (2) 17.6 cc. of milk and 17.5 cc. of weak acid (sp. gr. 1.78) 1 part water to 20 parts acid.
- (3) 17.6 cc. of milk and 21-23 cc. of weak acid of test No. 2.
- (4) 17.6 cc. of milk and 17.5 cc. of weak acid heated to 100° F. before using.

Note: For preparing the weak acid see F. & W. ¶ 74. *Never dilute sulfuric acid by pouring water into it.*

**Observations:** Record results and observations as follows:

| Sample |   | Temperature |      | % fat | Color of fat | Condition of fat |
|--------|---|-------------|------|-------|--------------|------------------|
|        |   | Milk        | Acid |       |              |                  |
| 1      | a |             |      |       |              |                  |
|        | b |             |      |       |              |                  |
| 2      | a |             |      |       |              |                  |
|        | b |             |      |       |              |                  |
| 3      | a |             |      |       |              |                  |
|        | b |             |      |       |              |                  |
| 4      | a |             |      |       |              |                  |
|        | b |             |      |       |              |                  |

**Conclusion:**

**Questions:** (1) Show by using figures how a 5% reading would be influenced if read at 180° F. instead of at 140° F.

(2) What precaution should be taken if sulfuric acid is too strong?

(3) Give 5 reasons why the fat column may be dark in color or contain black spots, or have dark curd directly underneath?

(4) Give 4 reasons why the fat column may be light in color, or contain light spots, or have light curd directly beneath?

**References:** F. & W. ¶ 72-79, inclusive; Van S. pp. 43-46; 65-70; Jud. 71; St. pp. 118-119.

EXERCISE NO. 8

**Object:** *To determine the effect of temperature of the milk and the acid on the color and condition of the fat column.*

**Procedure:** The ideal fat column should be a clear golden or amber color with a decided sparkle and should freely transmit light rays in an unbroken course within the column. A fat column lacking in any of the above indicates an imperfect test. There is no question that curd within or beneath the fat column affects the reliability of the results.

- A. Use 17.6 cc. of milk in each and make each of the following tests in duplicate:
- (1) 17.5 cc. of acid at normal temperatures (65°-75° F.)
  - (2) 17.5 cc. of acid at a low temperature. (Below 55° F.)
  - (3) 20-21 cc. of acid at a low temperature (Below 55° F.)
  - (4) 17.5 cc. of acid at a high temperature. (98°-105°F.)

**Observations:**

| Sample |   | Temperature |      | C. C. of Acid | % fat | Color | Condition |
|--------|---|-------------|------|---------------|-------|-------|-----------|
|        |   | Milk        | Acid |               |       |       |           |
| 1      | a |             |      |               |       |       |           |
|        | b |             |      |               |       |       |           |
| 2      | a |             |      |               |       |       |           |
|        | b |             |      |               |       |       |           |
| 3      | a |             |      |               |       |       |           |
|        | b |             |      |               |       |       |           |
| 4      | a |             |      |               |       |       |           |
|        | b |             |      |               |       |       |           |

**Conclusion:**

- Questions:**
- (1) Why should the fat column of a milk test be read so as to include both menisci?
  - (2) What effect on the test will the practice of allowing the acid and milk mixture to stand for a few minutes before centrifuging have? 24 hours?
  - (3) What may cause foam on top of the fat column? How may this defect be remedied?
  - (4) Give the important developments which resulted from the invention of the Babcock test.

**References:** F. & W. ¶ 79, 80, 307 (Table 2), 39, 41; Van S. pp. 64-70; Jud. pp. 66-72; St. pp. 118-119.

## EXERCISE NO. 9

**Object:** *To make an accurate test of partially churned milk.*

**Procedure:** A fat test of partially churned milk is one of the most difficult tasks of testing, for exceptional care must be taken to obtain reliable results.

A. Obtain about 500 cc. (1 pint) of milk, having a temperature below 60° F. Measure out duplicate samples. Divide the remaining milk into three approximately equal parts. Redivide one of the three lots in two equal parts and set aside in the locker for future use. Then proceed as follows:

(1) Cap one of the two remaining containers securely and shake with a churning motion until large butter granules form. Do not mistake foam for butter.

(a) Melt the fat in the churned sample by placing the container in warm water (110° F.) until all of the granules have liquified.

(b) Shake the mixture vigorously until completely mixed.

(c) *Sample at once* for testing.

Note: This step requires very great care and rapidity of operation, since liquid fat in the form of large fat globules separates very rapidly from the serum.

(2) Cap the second container securely and churn the sample as above.

(a) Add a known quantity of ethyl ether (10–20 cc. will usually suffice) to dissolve the butter granules.

(b) After the granules have been completely dissolved, mix thoroughly and test in duplicate. Calculate the per cent fat according to F. & W. ¶ 31.

Note: Care should be exercised in adding acid to warm milk or to milk containing ether. A few cc.'s should be added at a time and the bottle well shaken after each addition, as otherwise the action may be very violent.

**Observations:**

| Sample |   | Treatment       | % fat | Color | Condition |
|--------|---|-----------------|-------|-------|-----------|
| 1      | a | Normal          |       |       |           |
|        | b | “               |       |       |           |
| 2      | a | Heated to 110°  |       |       |           |
|        | b | “               |       |       |           |
| 3      | a | cc. ether added |       |       |           |
|        | b | “               |       |       |           |

**Conclusions:**

- Questions:** (1) Give the composition of milk of the four principal breeds of cattle.
- (2) Name the leading breeds of cattle which produce milk with relatively small fat globules; with relatively large fat globules.
- (3) What special precautions should be observed when using a hand tester in a cold room? How may these difficulties be overcome?
- (4) How may churning of small samples of milk in transit be avoided?

**References:** F. & W. ¶ 30, 31; Van S. pp. 1-23; Jud. p. 30, 45; St. pp. 41-45, 132.

**EXERCISE NO. 10**

**Object:** *To test thick soured milk for fat.*

**Procedure:** "When milk becomes sour, the casein is coagulated and the mechanical condition of the milk thereby changed so as to render difficult a correct sampling." (F. & W. ¶ 32.)

A. The two samples of milk held over from Exercise 9 to sour and thicken, are liquified by the following two methods:

(1) To one of the samples add a small quantity ( $\frac{1}{2}$ –1 gram) of some solid alkali (sodium hydroxide or potassium hydroxide). Shake from time to time, and when completely liquified obtain duplicate samples for testing.

Note: Do not try to hasten the process by a too rapid addition of the alkali.

(2) To the second sample add a definite quantity (2–5 cc. may be sufficient) of strong aqua ammonia in quantities of 1 cc., and shake well after each addition. When the sample has been completely liquified, obtain duplicate samples for testing. Calculate the correct test as for partially churned milk.

Note: (1) Extreme care should be exercised when adding acid to an alkaline solution. Avoid accidents by adding the acid in small quantities.

(2) A soda washing powder, e. g., Wyandotte may be substituted for either of the above alkalies.

**Observations:**

| Sample |   | cc. of milk | Alkali used | Amount of alkali | Reading | % fat |
|--------|---|-------------|-------------|------------------|---------|-------|
| 1      | a |             |             |                  |         |       |
|        | b |             |             |                  |         |       |
| 2      | a |             |             |                  |         |       |
|        | b |             |             |                  |         |       |
| 3      | a |             |             |                  |         |       |
|        | b |             |             |                  |         |       |

**Conclusion:**

- Question:** (1) If 8 cc. of ammonia are added to 200 cc. of sour milk and the reading obtained is 3.7, what is the correct test of the milk?
- (2) If a sample of milk obtained from a 3568 pound lot gives a test of 3.6 %, how many pounds of butter fat does the milk contain?
- (3) The following lots of milk are delivered by a patron during the week:
- Monday, 952 pounds testing 3.4 %.
  - Tuesday, 625 pounds testing 3.8 %.
  - Wednesday, 821 pounds testing 3.6 %.
  - Thursday, 690 pounds testing 3.5 %.
  - Friday, 582 pounds testing 3.7 %.
  - Saturday, 736 pounds testing 3.9 %
- What was the total quantity of fat delivered by the patron during the week?
- (4) What is the average test of the milk delivered by the patron in problem 3?

**References:** F. & W. ¶ 32, 196; Van S. 23, 24; Jud. pp. 41-58; St. p. 132.

**EXERCISE NO. 11**

**Object:** *To determine the rapidity with which fat rises on milk.*

**Procedure:** Since butterfat maintains its identity in the milk and is in suspension, it rises to the surface due to the fact that its specific gravity is considerably less than that of the serum. The rapidity with which the fat rises, however, depends on other factors beside specific gravity.

- A. Fill three cylinders with a well mixed sample of milk previously tested in duplicate.
- B. Test the top layer and the bottom layer of milk in cylinder number 1 after it has stood 10 minutes. First remove samples from the top—then by closing the upper end of the pipette, lower it in the milk and remove a sample from the bottom of the cylinder.
- C. Repeat the above process with the second cylinder after 20 minutes.
- D. Repeat the above process with the third cylinder after 30 minutes.

**Observations:**

| Sample |   | Time Stood | Layer | Results | Color | Condition |
|--------|---|------------|-------|---------|-------|-----------|
| 1      | a |            |       |         |       |           |
|        | b |            |       |         |       |           |
| 2      | a |            |       |         |       |           |
|        | b |            |       |         |       |           |
| 3      | a |            |       |         |       |           |
|        | b |            |       |         |       |           |
| 4      | a |            |       |         |       |           |
|        | b |            |       |         |       |           |

**Conclusions:**

- Questions:**(1) Name the fats of which butter fat is composed, and state how the various butter fats differ from each other.
- (2) How can true butter be distinguished from oleomargarine?
  - (3) Name the factors which influence the rapidity with which fat rises on milk.
  - (4) Describe butter fat globules with reference to size, number, shape, etc.

**References:** F. & W. ¶ 15, 17, 29; Van S. pp. 3-8; jud. pp. 25-26; St., pp. 20-23, 69-73.

EXERCISE NO. 12

**Object:** *To determine the effect of speed of the centrifuge on the reading of the fat column.*

**Procedure:** “It is vitally important that the required speed be always kept up;... if the speed is slackened, the results obtained are too low; it may be a few tenths, or even more than one per cent.” (F. & W. ¶ 67.)

- A. Make a duplicate test of a sample of milk with the centrifuge operated at the prescribed rate of speed.
- B. Make a duplicate test of the same sample of milk when the tester is being operated at one-half the correct rate of speed.

Note: The correct rate of speed for testers of various diameters is given in F. & W. ¶ 66.

**Observations:**

| Sample |   | Diameter of tester | Speed | % fat | Condition | Color |
|--------|---|--------------------|-------|-------|-----------|-------|
| 1      | a |                    |       |       |           |       |
|        | b |                    |       |       |           |       |
| 2      | a |                    |       |       |           |       |
|        | b |                    |       |       |           |       |

**Conclusions:**

- Questions:** (1) Explain the distribution of the components of milk in buttermaking, cheese making, and ice cream making. Write the answer in the form of a table.
- (2) What causes souring of milk? Explain.
  - (3) Discuss the condition of the casein as found in normal cow's milk.
  - (4) What is meant by the term viscosity of milk, and how may the relative viscosity be determined?

**References:** F. & W. ¶ 18, 19, 23-27 inclusive, 66, 67, 68; Van S. pp. 16, 131-132; Jud. pp. 26-29, 102 111; St. pp. 23-37.

**EXERCISE NO. 13**

**Object:** *To determine the effect of temperature on the reading of the fat column.*

**Procedure:** "A difference of 40° F. in temperature when reading a fat column obtained in the case of a 10% milk, will make a difference in the reading of .14%." (F. & W. ¶ 41, footnote.)

- A. Test a sample of milk in duplicate in the usual way.
- B. Remove the bottles from the tester and place in a water bath at 100° F. Read after 3 minutes.
- C. Place the bottles, after reading, in a water bath at 140° F. Read after 3 minutes.
- D. Place the bottles, after reading, in a water bath at 180° F. Read after 3 minutes.

Note: Be sure to have the upper surface of the fat column beneath the surface of the water in the water bath.

**Observations:**

| Sample |   | Temperature of water bath | % fat | Color | Condition |
|--------|---|---------------------------|-------|-------|-----------|
| 1      | a |                           |       |       |           |
|        | b |                           |       |       |           |
| 2      | a |                           |       |       |           |
|        | b |                           |       |       |           |
| 3      | a |                           |       |       |           |
|        | b |                           |       |       |           |

**Conclusions:**

- Questions:**
- (1) If the graduations of a test bottle measure 2.3 cc. from 0-10%, what would be the correct test of a sample of milk which reads 3.7% fat in this bottle?
  - (2) Mention at least six causes of variations in the test of a cow's milk.
  - (3) How do changes in the feed of a cow influence the quantity and the quality of her milk?
  - (4) How does the test of the milk yielded by a cow generally change with the advance of the period of lactation?

**References:** F. & W. ¶ 159-163 inclusive, 174-177 inclusive, 41 42; Van S. pp. 1-8, 66-67; Jud. pp. 30-59, 69-70; St. pp. 41-68.

EXERCISE NO. 14

**Object:** *To become acquainted with the proper method of obtaining and testing a composite sample of milk.*

**Procedure:** A composite sample of milk or cream is a mixture of each weighing of milk, taken in such a manner that it shall be proportional to the total weight of milk or cream tested.

- A. Test separately each of the three samples of milk provided, which were taken from lots of milk weighing 200, 300, and 400 pounds respectively. Calculate the true average test of the samples of milk according to F. & W. ¶ 196, 197, 198.
- B. Take an equal sample (one pipetteful) from each lot of milk, mix thoroughly and test in duplicate.
- C. Take a correct composite sample (2 pipettefuls from the 200 pound lot, 3 pipettefuls from the 300 pound lot, etc.) mix thoroughly and test in duplicate.

**Observations:**

| Sample |   | % fat | Average | Color | Condition |
|--------|---|-------|---------|-------|-----------|
| 1      | a |       |         |       |           |
|        | b |       |         |       |           |
|        | c |       |         |       |           |
| 2      | a |       |         |       |           |
|        | b |       |         |       |           |
| 3      | a |       |         |       |           |
|        | b |       |         |       |           |

**Conclusion:**

- Questions:** (1) Give a brief description of six different appliances used for obtaining a composite sample of milk.
- (2) Name the preservatives commonly used for composite samples of milk.
- (3) Why is it not advisable to practice composite sampling and testing of cream in creameries?
- (4) Describe in detail how composite samples should be cared for.

**References:** F. & W. ¶ 179-199 inclusive; Van S. pp. 24-31; Jud. pp. 46-58; St. pp. 109-112, 122.

EXERCISE NO. 15

**Object:** *To become acquainted with the principal of standardizing milk and cream.*

**Procedure:** The legal standard for fat in cream is 18% in the United States. It is permissible to reduce the test of rich cream to a minimum of 18% by the addition of a milk product. This process is known as standardizing. Standardizing milk or cream means the adjustment of the fat or solids content to a certain desired percentage. This is accomplished by the mixing in the proper proportion of two qualities of milk or cream, one higher, and the other lower than the desired standard.

- A. Make a test of two lots of milk provided. (One to contain over 5% fat and one less.) Record the tests.
- B. By using the Pearson square method calculate the porportion of each lot of milk required to make a 5% mixture.

| Tests of originals | Square | Proportion of each | Amt. of each |
|--------------------|--------|--------------------|--------------|
|                    |        |                    |              |
|                    |        |                    |              |
|                    |        |                    |              |

The proportion of each is derived by subtracting diagonally across the square using the desired standard either as the subtrahend or minuend as the case may be. The smaller number is always subtracted arithmetically from the larger.

- C. Calculate the amount of each lot necessary to prepare exactly 100 cc. of a mixture testing 5% fat.
- D. Make an accurate test of the prepared mixture.

**Observations:**

| Sample |   | Test | Proportion | cc. of each |
|--------|---|------|------------|-------------|
| 1      | a |      |            |             |
|        | b |      |            |             |
| 2      | a |      |            |             |
|        | b |      |            |             |
| 3      | a |      |            |             |
|        | b |      |            |             |

- Questions:** (1) How many pounds of 3.5% milk would have to be added to 95 pounds of 33% cream to make a mixture testing 22% fat?
- (2) How many pounds of skimmilk testing 0.0% fat would have to be mixed with 35% cream to produce 150 pounds of 22% cream?
- (3) How many pounds of 3.2% milk would have to be mixed with 38% cream to make a mixture testing 25% fat?
- (4) How many pounds of 22% cream can be produced from 5000 pounds of 3.5% milk?

Van S. pp. 263-268; Jud pp. 72-76; St. pp. 181-184.

**EXERCISE NO. 16**

**Object:** *To become acquainted with the Sin-acid test for fat in milk.*

**Procedure:** The sin-acid (without acid) solution is prepared as follows:  
Mix 7 cc. of amyl alcohol with 31 cc. of 95% ethyl alcohol, and add the mixture to 64 cc. of 0.8 normal sodium hydroxide solution.

**A.** Test a lot of milk in duplicate by the Babcock method.

**B.** Test the same lot of milk by the sin-acid test as follows:

Method 1.

(1) Place 17.6 cc. of milk in a 10% milk test bottle and add 17.5 cc. of sin-acid solution.

(2) Mix the sample thoroughly with a rotary motion, and finally with a churning motion, with the tip of the bottle closed with the finger.

(3) The bottles should then be placed in hot water (190°–200° F.) for 10 minutes and again shaken, and filled with hot water (190°–200° F.) up to the neck. The bottles are then replaced in the water bath (190°–200° F.) for 30 minutes. The fat is then brought into the neck by adding hot water (190°–200° F.), placed in a water bath at 140° F. for 5 minutes and then read.

**C.** Sin-acid test—Method (2).

(1) Perform same as 1 and 2 of **B** above.

(2) The bottles are placed in a water bath at 190°–200° F. and shaken from time to time until the curd is dissolved.

(3) Place in centrifuge and whirl for 3 minutes; fill with hot water (140° F.) into neck, place in water bath at 140° F. for 5 minutes and read.

**Observations:**

| Sample |   | % fat | Color | Condition |
|--------|---|-------|-------|-----------|
| 1      | a |       |       |           |
|        |   |       |       |           |
| 2      | a |       |       |           |
|        | b |       |       |           |
| 3      | a |       |       |           |
|        | b |       |       |           |

**Conclusions:**

- Questions:** (1) Name at least six tests, other than the Babcock, for fat in milk.
- (2) By use of a problem, illustrate that it is incorrect to obtain composite samples of milk with a small dipper.
  - (3) How should a composite sample of milk be prepared for the test?
  - (4) What special precautions should be observed when a hand tester is used?

**References:** F. & W. ¶ 179–199, inclusive, ¶ 69, 70, 71; Van pp. 31, 70–72; St. pp. 112–114.

**EXERCISE NO. 17**

**Object:** *To become acquainted with the Röse-Gottlieb method for the determination of fat in milk.*

**Procedure:** The Mojonnier tester, largely used in milk condensing factories and ice cream factories, is based on the Röse-Gottlieb.

**A.** Make a duplicate test of the milk, provided, by the Babcock test.

**B.** Pipette 10 grams of the milk provided into a specially constructed Röhrig extraction tube, and proceed as follows:

- (1) Add 1 cc. of concentrated ammonia and mix thoroughly.
- (2) Add 10 cc. of 92% ethyl alcohol and mix thoroughly.
- (3) Add 25 cc. of washed ethyl ether and mix thoroughly.
- (4) Add 25 cc. of petroleum ether and mix thoroughly.
- (5) close the tube with a moist stopper and allow to stand for 6 hours.
- (6) Read at the base of the clear liquid and at the top and drain off an aliquot portion of the clear liquid into a clean carefully weighed aluminum evaporating dish.
- (7) Evaporate the ether from the dish under a hood, until all ether has evaporated. Cool the dish and carefully weigh again. The increase in weight represents the fat in that portion of the solution drawn off. The total weight of the fat can be calculated and since a 10 gram sample of milk was used, it is easy to determine the per cent of fat present.

Note: The temperature of the hot plate should be in the neighborhood of 135° C. (275°F.).

**Observations:**

| Sample |   | Grams milk | % of ether solution used | Weight of empty dish | Weight of contents after evaporation | Amt. of fat present |
|--------|---|------------|--------------------------|----------------------|--------------------------------------|---------------------|
| 1      | a |            |                          |                      |                                      |                     |
|        | b |            |                          |                      |                                      |                     |
| 2      | a |            |                          |                      |                                      |                     |
|        | b |            |                          |                      |                                      |                     |

**Conclusions:**

**Questions:** (1) How would the Röse-Gottlieb procedure differ, if a substance high in fat were tested?

(2) If a patron delivers 525 pounds of milk testing 3.8% and the price of butter fat were 42c, what would he receive for the milk?

(3) If the farmer in problem 2 were paid at the rate of 1.80 for 100 pounds of 3.5% milk and 5c for each .1% above or below this test, what would he receive for the milk?

(4) What would he get for the milk at the rate of \$1.50 per 10 gallon can?

**References:** F. & W. ¶ 251; Van S. 253-254.

Several exercises are suggested below as substitutes or additions if it is felt that a need for such exercises exists. Merely a brief outline, with no mention of observations, conclusions, or questions is given.

### EXERCISE NO. 18

**Object:** *To determine the influence of souring of milk on its fat content.*

**Procedure:**

- A. Test a lot of milk in duplicate.
- B. Measure out 17.6 cc. of the above lot of milk into each of two 10% milk test bottles, and set these aside until the next exercise.
- C. Test the two soured samples of milk by the same method used for sample A and compare results.

**References:** F. & W. ¶ 32; Van S. p 23; St. p 132

### EXERCISE NO. 19

**Object:** *To determine the variation in the fat content of the milk of one cow during various stages in the milking process.*

**Procedure:**

- A. Strip some of the first milk from each of the four quarters into a sample bottle. Label properly.
- B. Repeat this with another bottle when one-half through milking. Label.
- C. Strip the last milk from each of the four quarters into a third bottle. Label.
- D. Test each of the above samples in duplicate.

**References:** F. & W. ¶ 168; Van S. p. 8; Jud. p. 35; St. pp. 49-51.

### EXERCISE NO. 20

**Object:** *To determine the variation in the fat content of milk of one cow from one milking to another.*

**Procedure:** Obtain a representative sample of milk from each of six milkings of one cow and test each sample in duplicate.

**References:** F. & W. ¶ 160-164 inclusive, Van S. p. 7; Jud. pp 35-38, St. p 48.

### SERIES C.

#### Testing cream for fat

**Materials** necessary for 10 students:

*100 cc. glymol or "red reader."*

#### EXERCISE NO. 21

**Object:** *To become acquainted with one method of testing cream with the Babcock test.*

**Procedure:** "Cream may be tested by the Babcock test in the same manner as milk, and the results obtained are accurate when necessary care has been taken in sampling the cream and measuring the fat." (F. & W. ¶ 85.)

- A. Carefully balance a 30% cream test bottle on the balances provided.
- B. Weigh out exactly 18 grams of a well mixed lot of cream. Make all tests in duplicate. Add approximately 16 cc. of sulfuric acid and test as whole milk.
- C. Place the bottles in a hot water bath (135°-140° F.) for 5 minutes and read immediately by including all of the lower meniscus and one-third of the upper meniscus.
- D. Replace bottles in the water bath for 5 minutes, and add a few drops of glymol (colored Petrolatum) and read, including both extremes of the *fat* column.

#### Observations:

| Sample |   | % fat | Color | Condition |
|--------|---|-------|-------|-----------|
| 1      | a |       |       |           |
|        | b |       |       |           |
| 2      | a |       |       |           |
|        | b |       |       |           |

#### Conclusion:

- Questions:** (1) What is the size of the smallest graduation on the neck of a 30%, 6-inch, 18 gram test bottle?
- (2) What is the object of using glymol or "red reader" before reading cream tests?
- (2) When should glymol be added to the fat column?
- (4) How should cream tests be read without glymol? Outline the various suggestions.

**References:** F. & W. ¶ 85-89 inclusive; Van S. pp 73-92; Jud. pp 75-85; St. pp 119-128.

**EXERCISE NO. 22**

**Object:** *To demonstrate the fallacy of testing cream by volume.*

**Procedure:** "Several factors tend to render inaccurate the measuring of cream for the Babcock test, and correct results can therefore only be obtained by weighing the cream." (F. & W. ¶ 86).

A. Test a sample in duplicate as in exercise 21.

B. Measure out a 17.6 cc. sample of the above cream into each of two cream test bottles and complete the test in the usual manner.

Note: In case the 9 gram sample is the legal sample, weigh out 9 grams of cream under A above, add about 9 cc. of water and mix. Then add 17.5 cc. of sulfuric acid, mix, and test as in Exercise 21.

**Observations:**

| Sample |   | % fat | Color | Condition |
|--------|---|-------|-------|-----------|
| 1      | a |       |       |           |
|        | b |       |       |           |
| 2      | a |       |       |           |
|        | b |       |       |           |

**Conclusion:**

**Questions:** (1) Give three reasons why the cream samples should be weighed rather than measured with a pipette.

(2) Give a table of figures to show how the richness of cream influences its weight.

(3) Explain the use of, and describe the construction of the Wisconsin hydrostatic cream balance.

(4) Give a formula for calculating the test of a sample of cream if less than 18 grams are used in an 18 gram test bottle.

**References:** F. & W. ¶ 85-89 inclusive; Van S. pp 73-92; Jud. pp 75-85; St. pp 119-128.

**EXERCISE NO. 23**

**Object:** *To determine the accuracy of using various weights of cream for the Babcock test.*

**Procedure:** "The smaller the quantity of cream taken for a sample the greater is the error introduced by inaccurate weighings or readings. The result is rendered more accurately if two or three tests of a sample are made and the readings averaged." (F. & W. ¶ 91.)

- A. Accurately weigh out 18 grams of cream into each of two cream test bottles and test as in exercise 21.
- B. Accurately weigh out 9 or 10 grams of cream into each of two cream test bottles and use sulfuric acid in proportion. Then complete the tests as for part A. The per cent of fat may be calculated by the following formula.

$$\frac{18 \times \text{Reading}}{\text{grams cream used}} = \% \text{ fat}$$

Note: Any weight of cream from 3 grams up may be used.

**Observations:**

| Sample |   | Reading | % fat | Color | Condition |
|--------|---|---------|-------|-------|-----------|
| 1      | a |         |       |       |           |
|        | b |         |       |       |           |
| 2      | a |         |       |       |           |
|        | b |         |       |       |           |

**Conclusion:**

- Questions:** (1) Explain how a sample of cream may be tested by using 10% milk test bottles.
- (2) What is the legal standard in Wisconsin for fat in cream?
- (3) If the weight of a 10 gallon can of water is 83.3 pounds, what would be the weight of a 10 gallon can of 25% cream? 20% cream?
- (4) If 295 pounds of cream test 33% fat, how many pounds of fat does it contain?

**References:** F. & W. ¶ 85-96 inclusive, 305, 307, Table XVI; Van S. pp 73-92, Jud pp 75-85; St. pp 119-128.

EXERCISE NO. 24

**Object:** *To compare several methods of treating the cream sample during the testing process.*

**Procedure:** In factories where the aim is speed of operation, certain-so-called short cuts have been adopted, which, if carefully used will give good results.

- A. Accurately weigh out 18 grams of cream into each of two cream test bottles, and test as in exercise 21, using less than 17.5 cc. of sulfuric acid.
- B. Accurately weigh out 18 grams of cream, in each of two cream test bottles, add 17.5 cc. of acid to each and mix thoroughly. Then add lukewarm water (80°-90° F..) up to the neck and whirl for five minutes and after filling with water, again for one minute.
- C. Accurately weigh out 9 grams of cream into each of two cream test bottles, add an equal quantity of water at room temperature. Then add 17.5 cc. of acid and test as A above. Calculate the test.

Observations:

| Sample |   | Weight of Sample | Reading | % fat | Color | Condition |
|--------|---|------------------|---------|-------|-------|-----------|
| 1      | a |                  |         |       |       | /         |
|        | b |                  |         |       |       |           |
| 2      | a |                  |         |       |       |           |
|        | b |                  |         |       |       |           |
| 3      | a |                  |         |       |       |           |
|        | b |                  |         |       |       |           |

Conclusions:

- Questions:**
- (1) If a 7.5 gram sample of cream gives a reading of 15.5% what is the test of the cream?
  - (2) How are cream test samples handled for cream that is gathered on the route in large cans?
  - (3) What advantages has gathering cream in the patron's own cans over mixing the cream from all patrons on the route?
  - (4) Name at least 3 types of cream scales and give the advantages and disadvantages of each.

**References:** F. & W. ¶ 91, 200-211 inclusive; Van S. pp 73-92; Jud. pp 46-52, 75-85; St. pp 119-128.

**SERIES D.****Testing Skimmilk, Buttermilk, and Whey for Fat.**

**Materials** necessary for 10 students:

20—Double necked test bottles graduated in .01% up to .5%.

5—25 cc. graduated cylinders.

**EXERCISE NO. 25**

**Object:** To test skimmilk for fat using two different quantities of acid and varying whirling time.

**Procedure:** It has been found that if a sample of skimmilk is tested for fat as whole milk is tested, the result will be much less than the actual amount of fat present.

- A. After thoroughly mixing the sample of skimmilk, measure out 17.6 cc. into a double necked bottle, add 17.5 cc. of sulfuric acid, mix, and whirl as for whole milk. Read without a water bath.
- B. Obtain a 17.6 cc. sample as above, but add at least 22 cc. of sulfuric acid in two portions, mixing thoroughly after each addition. Whirl at the usual speed as follows: 15-3-2.
- C. Use whole milk test bottles and add 17.5 cc. of acid to 17.6 cc. of skimmilk and complete the test as for whole milk.

**Observations:**

| Sample |   | cc. acid | Time of Whirling | % fat | Color | Condition |
|--------|---|----------|------------------|-------|-------|-----------|
| 1      | a |          |                  |       |       |           |
|        | b |          |                  |       |       |           |
| 2      | a |          |                  |       |       |           |
|        | b |          |                  |       |       |           |
| 3      | a |          |                  |       |       |           |
|        | b |          |                  |       |       |           |

**Conclusion:**

**Questions:** (1) Why are double necked bottles to be placed with the filling tube toward the center of the tester?

(2) What reason can be given for the fact that not all of the fat gathers in the neck of the bottle when skimmilk is tested for fat?

(3) If a separator leaves .2% fat in the skimmilk, how much fat would be lost in 2855 pounds of skimmilk?

(4) Why should a sample of skimmilk not be pipetted into the test bottle immediately after separating?

**References:** F. & W. ¶ 97, 98, 99, 100; Van S. pp. 93-95; Jud p. 85; St. pp. 129-130.

EXERCISE NO. 26

**Object:** *To become acquainted with the Babcock test for fat in buttermilk.*

**Procedure:** The general opinion among creamery operators has been that the loss of fat in buttermilk did not exceed .2%. Recent investigations, however, have disclosed the fact that the loss rarely is less than .4%. The amount lost depends greatly on the methods of handling the cream and the churns.

- A. Thoroughly mix a sample of butter milk. Rapidly pipette 17.6 cc. into a double necked bottle and add 20 cc. of acid. Mix well. Whirl a total of 10 minutes in three steps.
- B. Measure out 17.6 cc, of buttermilk into a second double necked bottle and add at least 22–25 cc. of sulfuric acid in two portions, mixing carefully after each addition. Whirl in a hot tester as follows: 15–3–2.
- C. Repeat “A” above by using an 8.8 cc. sample of buttermilk and 10 cc. of sulfuric acid.
- D. Repeat “B” above by using an 8.8 cc. sample and at least 11–13 cc. of acid and whirling in a hot tester 15–3–2.
- E. Test one 17.6 cc. sample of buttermilk in a whole milk test bottle. Use 20 cc. of acid and whirl a total of 20 minutes.

Note: Method “A” is the old recommended method by which results below .2% were usually obtained, while method “B” and “D” are the improved methods by which results within .1 % of actual gravimetric analysis are obtained.

**Observations:**

| Sample | cc.<br>Butter<br>milk | cc. acid | Length<br>whirling | % fat | Color Condition |
|--------|-----------------------|----------|--------------------|-------|-----------------|
| 1      | 17.6                  |          | 10                 |       |                 |
| 2      | 17.6                  |          | 20                 |       |                 |
| 3      | 8.8                   |          | 10                 |       |                 |
| 4      | 8.8                   |          | 20                 |       |                 |
| 5      | 17.6                  |          | 20                 |       |                 |

**Conclusions:**

- Questions:** (1)The fat test of 150 pounds of whole milk is 3.4%, and the fat test of 128 pounds of skimmilk from this milk is .04%. What should be the approximate test of the cream?
- (2) Briefly describe the Association test for fat in buttermilk.

- (3) It is generally assumed that the weight of the buttermilk obtained is equal to the pounds cream minus the pounds butterfat. If 610 pounds butter are produced from 2000 pounds of cream testing 25% fat and the test of the buttermilk is .4% what is the per cent fat in the butter?
- (4) How many pounds of fat were lost in the buttermilk in problem (3)?

**References:** F. & W. ¶ 101; Van S. pp. 93-95; Jud. pp. 85-86; St. pp. 129-130.

EXERCISE NO. 27

**Object:** *To test a sample of whey for fat by the Babcock test.*

**Procedure:** The fat in the whey when cheese is made usually varies from about .4% to over 1.0%. However, most of this fat can be recovered by running the whey through a specially constructed separator.

- A. Measure out 17.6 cc. of a well mixed sample of whey into a double necked bottle, and add 10–15 cc. of sulfuric acid. Mix and whirl a total of 10 minutes.
- B. Measure out an 8.8 cc. sample of whey and add 5–7 cc. of acid, mix and proceed as for “A” above.
- C. Measure out a 17.6 cc. sample of well mixed whey into a whole milk test bottle and proceed exactly as for “A” above.

**Observations:**

| Sample | cc. Whey | cc. Acid | % fat | Color | Condition |
|--------|----------|----------|-------|-------|-----------|
| 1      |          |          |       |       |           |
| 2      |          |          |       |       |           |
| 3      |          |          |       |       |           |

**Conclusions:**

- Questions:** (1) Why is more acid required for testing skim milk and buttermilk, and less when testing whey than for whole milk?
- (2) What other constituents besides fat are found in whey?
- (3) How does whey compare in feeding value with skim milk and butterfat?
- (4) What is skim milk worth for hog feed when compared with corn, or hogs per pound live weight?

**References:** F. & W. ¶ 101; Van S. pp. 93–95; 16; Jud. p. 86.

## SERIES E.

## Use of the Lactometer.

**Materials** necessary for 10 students.

2—Pounds butter salt (best grade).

1—gallon distilled water.

## EXERCISE NO. 28

**Object:** *To test the accuracy of a lactometer.*

**Procedure:** When a new lactometer is purchased and no tested lactometers are available for checking the accuracy of the new one, it may be necessary to use some other method for checking.

A. Place exactly 300 cc. of distilled water into each of 3 containers labeled A, B, and C respectively. To cylinder A, add 9 grams of pure dairy salt, to B, add 12 grams of pure dairy salt, and to C add 15 grams of pure dairy salt. Allow the salt to dissolve and bring the mixture to exactly 60° F.

B. Insert the lactometer to be tested successively into each of the three solutions, A, B, and C, carefully wiping the lactometer before each insertion. The readings on the lactometer should indicate 1.022, 1.029, and 1.036 specific gravity respectively for A, B, and C.

Note: Be sure to have the solution well mixed before inserting the lactometer.

**Observations:**

| Salt solution | Correct reading | Lactometer reading | Error |
|---------------|-----------------|--------------------|-------|
| A             | 1.022           |                    |       |
| B             | 1.029           |                    |       |
| C             | 1.036           |                    |       |

**Conclusion:**

**Questions:** (1) Define the term specific gravity.

(2) What is the object of knowing the specific gravity of certain lots of milk?

(3) What is a lactometer, and on what principal is it based.

(4) Describe fully the markings on the neck of a Quevene lactometer.

**Reference:** F. & W. ¶ 109, 110, 118, 118a; Van S. pp. 175-179; Jud. pp. 91-101; St. pp. 136-143.

EXERCISE NO. 29

**Object:** *To become acquainted with the use of the Quevene lactometer for determining the specific gravity, the solids not fat, the total solids, and the specific gravity of total solids of milk.*

**Procedure:** The normal specific gravity of cow's milk varies from 1.029-1.035 at 60° F., the average being about 1.032. The solids no fat (S N F) range slightly above 8.5%, and the total solids (T S) is equivalent to the S N F plus the fat. The specific gravity of T S varies from 1.25-1.34, usually averaging above 1.30. The addition of a foreign substance or the removal of a constituent of milk will usually effect one or more of the above constituents, hence a knowledge of lactometer work aids in the detection of adulterations.

- A. Mix a sample of milk thoroughly and obtain a 17.6 cc. sample for a fat determination. Fill the glass lactometer cylinder with milk and insert the lactometer. Allow the lactometer to come to rest and read the temperature. If it is above 70° F. or below 50° F. cool or warm the sample as necessary. If the temperature is within the range given, read the point on the lactometer scale to which it has sunken.
- B. Make temperature corrections (F. & W. ¶ 111, 112, 113).
- C. Make calculations necessary to fill in data required under observations.

Note: See F. & W. ¶ 118 for cleaning lactometer, and be sure the lactometer is dry before it is inserted in the milk.

**Observations:**

| Sam-<br>ple | %<br>fat | Lact.<br>reading | Temper-<br>ature | Corrected<br>reading | %<br>SNF | %<br>TS | Sp. gr.<br>of milk | Sp. gr.<br>of solids |
|-------------|----------|------------------|------------------|----------------------|----------|---------|--------------------|----------------------|
| 1           |          |                  |                  |                      |          |         |                    |                      |
| 2           |          |                  |                  |                      |          |         |                    |                      |

**Conclusions:**

- Questions:**
- (1) Why is it not possible to obtain the specific gravity of milk immediately after milking?
  - (2) Why should the lactometer reading be taken immediately after the milk is mixed and the lactometer inserted?
  - (3) How should the lactometer be read with reference to the meniscus?
  - (4) Give the formulae for determining the SNF, TS, and the specific gravity of TS.

**References:** F. & W. ¶ 109-121, inclusive, 125; Van S. pp. 175-196; Jud. pp. 91-101; St. pp. 136-143.

## EXERCISE NO. 30

**Object:** *To become acquainted with adulteration formulae and their verification.*

**Procedure:** A number of formulae have been developed for calculating the extent of adulteration, if skimming or watering, or both have been practiced.

A. Obtain the lactometer reading and the fat test of a one pint sample of normal milk.

B. Divide the pint of milk into two equal parts and proceed as follows:

(1) Add water to one part at the rate of 5 cc. per 100 cc. of milk, and test as "A" above.

(a) On the basis of the control sample, calculate the per cent of water added to the original milk by the following formula:

$$\frac{100 \times \text{control for SNF}}{\text{SNF in suspected sample}} - 100$$

(b) On the basis of the legal standard for SNF, calculate the per cent of water added to the original milk by the following formula:

$$\frac{100 \times \text{leg. standard for SNF}}{\text{SNF in suspected sample}} - 100.$$

(c) Add skim milk, a little at a time, from a graduate until the lactometer is again as in A above. Record the amount of skim milk used.

(2) To the second half pint add water at the rate of 10 cc. per 100 cc. of milk and proceed exactly as for the first pint.

**Observations:**

| Sample |   | % fat | Corrected Lactometer reading | % SNF | % water added | cc. skim-milk added | % adulteration |           |
|--------|---|-------|------------------------------|-------|---------------|---------------------|----------------|-----------|
|        |   |       |                              |       |               |                     | Formula A      | Formula B |
| 1      |   |       |                              |       |               |                     |                |           |
| 2      | a |       |                              |       |               |                     |                |           |
|        | b |       |                              |       |               |                     |                |           |
| 3      | a |       |                              |       |               |                     |                |           |
|        | b |       |                              |       |               |                     |                |           |

**Conclusion:**

- Questions:** (1) What is meant by the term "control sample" when we refer to testing milk for total solids?
- (2) What is the legal standard for SNF of cow's milk?
- (3) What effect on the lactometer will the addition of preservatives have? How may this difficulty be overcome?
- (4) How does the New York board of Health lactometer differ from the Quevene? How may the readings of one be converted to those of the other?

**References:** F. & W. ¶ 114, 117, 127; Van S. pp. 175-188; Jud. pp. 91-101; St. pp. 136-143.

## EXERCISE NO. 31

**Object:** *To determine the adulteration of an unknown sample of milk.*

**Procedure:** The table of adulteration which follows is to be compared with the control sample if one is provided or it may be used with the factors usually assigned to normal milk.

|                        | Normal      | Watered | Skimmed        | Skimmed and Watered    |
|------------------------|-------------|---------|----------------|------------------------|
| Fat                    | 3%+         | Lower   | Lower          | Lower                  |
| Sp. Gr. of milk        | 1.029—1.035 | Lower   | Higher         | Normal—higher or lower |
| % S. N. F.             | 8.5%+       | Lower   | Nor. or higher | Lower                  |
| % T. S.                | 11.5%+      | Lower   | Lower          | Lower                  |
| Sp. Gr. of milk solids | 1.25—1.34   | Normal  | Higher         | Higher                 |

- A. Make a lactometer and fat test of the control sample and include all calculations.
- B. By using the Babcock test and the lactometer, analyze the “adulterated” sample of milk and report the adulteration.
- C. Calculate the per cent reduction of SNF by the following formula:

$$\frac{\text{SNF in control} - \text{SNF in adulterated}}{\text{SNF in control}} \times 100.$$

- D. Calculate the per cent reduction of fat by the following formula:

$$\frac{\% \text{ Fat in control} - \% \text{ in adulterated}}{\% \text{ Fat in control}} \times 100.$$

If the sample is watered only the two results obtained should correspond. If the sample is skimmed only, no appreciable answer will be obtained from the 1st formula. Usually the answer is negative. If an appreciable answer is obtained from the first formula, and if the result from the last formula is greater than that from the first, the sample is Watered and Skimmed. The difference between the two results gives the % of skimming.

**Observations:**

| Sample | Fat | Sp. Gr.<br>of milk | SNF | TS | Sp. Gr.<br>of solids | Adultera-<br>tion | % adultera-<br>tion |
|--------|-----|--------------------|-----|----|----------------------|-------------------|---------------------|
| 1      |     |                    |     |    |                      |                   |                     |
| 2      |     |                    |     |    |                      |                   |                     |

**Conclusions:**

**Questions:** (1) What is the per cent SNF and what is the condition of each of the following samples of milk when compared with the table given?

- (a) 32.0 at 58° F. 4.0% fat
  - (b) 33.5 at 56° F. 2.5% fat
  - (c) 30.0 at 63° F. 3.5% fat
  - (d) 28.0 at 54° F. 2.5% fat
  - (e) 27.4 at 69° F. 2.4% fat
- (2) How does the SNF content of milk vary with the fat content?
- (3) What is the specific gravity of pure butter fat at 135°–140°F.?
- (4) How can cheese yield be calculated when using the Babcock test and the lactometer?

**References:** F. & W. ¶ 121–126, inclusive, 224; Van S. pp. 175–189; Jud. pp. 91–101; St. pp. 136–143.

## SERIES F.

## Acidity Determination of Dairy Products.

**Materials** necessary for 10 students:

- 30—Grams sodium hydroxide ( $\text{NaOH}$ ).
- 100—cc. phenolphthalein solution (indicator).
- 1000—Farrington alkaline tablets.
- 500—cc.  $\frac{1}{10}$  normal oxalic acid solution (prepared by adding 500 cc. of distilled water to 3.151 grams C. P. oxalic acid crystals ( $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ )).
- 10—25 cc. pipettes.
- 10—Small dippers (20 gauge shot gun shell size).
- 5—5 gram weights.
- 10—500-1000 cc. reagent bottles.
- 5—Kg. distilled water.

## EXERCISE NO. 32

**Object:** To become acquainted with the preparation of a  $\frac{1}{10}$  normal sodium hydroxide solution, and of a standard Farrington Alkaline Tablet Solution.

**Procedure:** In preparing solutions for acidity testing, it is essential that there be a standard strength to work on. The standard adopted is the normal solution.

A normal solution of an acid is one which, approximately speaking, contains 1.0 grams of replaceable hydrogen per liter of solution, and a normal solution of an alkali is one that will just neutralize a normal solution of an acid volume for volume. Another definition of a normal solution is as follows: A normal solution is one which contains the molecular weight of the material divided by the hydrogen equivalent of the active element, dissolved and diluted to a liter. Consequently a normal solution of an alkali is a solution that contains the chemical equivalent of 1.0 grams of replaceable hydrogen per liter.

More accurate work can be done with weak solutions, hence it is customary to prepare  $\frac{n}{10}$  solutions of an alkali for titrating the acidity of milk.

A. To prepare a  $\frac{1}{10}$  normal ( $\frac{n}{10}$ ) sodium hydroxide ( $\text{NaOH}$ ) solution proceed as follows:

- (1) Carefully balance a clean dry stoppered test tube on an ordinary butter or cheese moisture test scale.
- (2) Place a piece (2-4 grams) of  $\text{NaOH}$  in the test tube, stopper tightly, and obtain the exact weight of the  $\text{NaOH}$ . Transfer the  $\text{NaOH}$  to a clean bottle. Calculate the volume to which to dilute with distilled water to make an  $\frac{n}{10}$  solution as follows:

$$\frac{\text{grams NaOH} \times 1000}{4} = \text{Total volume of solution}$$

4

Rinse out the test tube into the bottle.

- (3) Allow the NaOH to dissolve, mix well and place at least 20 cc. of the solution in a thoroughly cleaned graduated burette.
  - (4) Measure out exactly 17.6 cc. of a prepared  $\frac{n}{10}$  oxalic acid solution into a clean white cup. Add two drops of phenolphthalein indicator prepared according to F. & W. ¶ 131. Titrate this against the NaOH solution in the burette. If exactly 17.6 cc. of NaOH solution produces a faint pink color, the NaOH solution is exactly  $\frac{n}{10}$ . If more than 17.6 cc. are required, it is too weak. If less is required, it is too strong. From the actual amount required, it is possible to calculate the amount of additional water or NaOH required to make it the proper strength.
- B. To prepare an  $\frac{n}{10}$  Farrington alkali table solution.
- (1) Measure out a definite quantity of distilled water into a clean bottle and calculate the number of Farrington alkaline tablets to add as follows:

$$\frac{\text{cc. water used} \times 25}{97} = \text{number of tablets necessary.}$$

97

The rule for preparing an  $\frac{n}{10}$  solution is to use 25 tablets to 97 cc. of water.

Note: The Standard Farrington alkaline tablet solution is prepared by using 5 tablets to 97 cc. of water. An  $\frac{n}{10}$  Oxalic acid solution is prepared by weighing out 6.3 grams of oxalic acid crystals ( $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ ) and add enough distilled water to make 1000 cc.

#### Observations:

|  |               | cc. Water | Grams NaOH or<br>number of tablets |
|--|---------------|-----------|------------------------------------|
|  | NaOH solution |           |                                    |
|  | Farrington's  |           |                                    |

Notes on preparation.

#### Conclusion:

- Questions:**
- (1) How should an  $\frac{n}{10}$  KOH solution be prepared?
  - (2) What is the strength of a Standard Farrington alkaline tablet solution?
  - (3) Explain in detail why 6.3 grams of C. P. oxalic acid crystals are used to make up an  $\frac{n}{10}$  solution?
  - (4) Why is sulfuric acid not used for making  $\frac{n}{10}$  solutions?

**References:** F. & W. ¶ 128-141, inclusive; Van S. 131-139; Jud. pp. 102-106; St. pp. 132-136.

## EXERCISE NO. 33

**Object:** *To test several lots of milk for acidity, using the  $\frac{N}{10}$  NaOH solution (Mann's test) and various sized pipettes.*

**Procedure:** An acidity test is useful when:

- (1) Grading milk or cream at the receiving room.
- (2) Ripening cream for butter making.
- (3) Making cheese.
- (4) Bottling milk or cream in a city milk plant.
- (5) Condensing milk.
- (6) Making cultured milks.
- (7) Manufacturing casein.

- A. With an 8.8 cc. pipette measure out 8.8 cc. of well mixed milk from lot Number 1, into a clean white cup. Add one drop of phenolphthalein indicator and from a burette graduated to tenths of a cc., and while stirring the milk continuously, add enough  $\frac{N}{10}$  NaOH solution to produce a permanent faint pink color. Each cc. of NaOH solution used indicates .1% acidity.
- B. Use a 17.6 cc. pipette for measuring out a sample of the same lot of milk used for A and proceed as above. Use two drops of phenolphthalein indicator. Record the number of cc. of  $\frac{N}{10}$  NaOH solution used and calculate the per cent of acidity present by using the following formula:

$$\frac{\text{cc. } \frac{N}{10} \text{ NaOH} \times .009 \times 100}{\text{cc. sample}} = \% \text{ acidity.}$$

- C. Use a 25 cc. sample of the same milk and proceed as in above.
- D. Perform the above three operations on each of the lots of milk provided.

**Observations:**

| Sample |   | cc. milk | cc. $\frac{N}{10}$ NaOH | % acidity |
|--------|---|----------|-------------------------|-----------|
| 1      | a |          |                         |           |
|        | b |          |                         |           |
|        | c |          |                         |           |
| 2      | a |          |                         |           |
|        | b |          |                         |           |
|        | c |          |                         |           |
| 3      | a |          |                         |           |
|        | b |          |                         |           |
|        | c |          |                         |           |

**Conclusions:**

**Questions:** (1) What will be the effect if a bottle of NaOH solution is left unstoppered?

(2) What is the cause of acidity in milk? What is the average acidity of fresh milk?

(3) How is the phenolphthalein indicator solution prepared?

(4) If 20 cc. of cream require 15 cc.  $\frac{N}{10}$  NaOH solution for neutralization, what is the per cent acid in the sample?

**References:** F. & W. ¶ 128–152, inclusive; Van S. 131–151; Jud. pp. 102–106; St. pp. 132–136.

**EXERCISE NO. 34**

**Object:** To compare Mann's and the Farrington Alkaline Tablet acidity tests.

**Procedure:** A Standard Farrington Alkaline tablet solution is prepared by dissolving 5 tablets in 97 cc. of water. The strength of this solution should be such that if an 18 gram (17.6 cc.) sample of milk is used, 1 cc. of the solution will indicate exactly .01% acidity. If 97 cc. of the solution were necessary to produce a faint pink color in an 18 gram sample, there would then be present .97% lactic acid or  $18 \times .0097 = .1746$  grams of lactic acid would be present in the 18 gram sample. Since 5 tablets were used in preparing the 97 cc. each tablet will neutralize  $.1746 \div 5 = .03492$  grams of lactic acid. Since there is one tablet in 19.4 cc. of water, each cc. of the Standard solution will neutralize .0018 grams of lactic acid. Therefore  $.0018 \div .09 = .02 = \frac{2}{100}$  or the solution is  $\frac{1}{50}$  normal. This illustration shows how it is possible to prepare a solution of any desired strength.

- A. Use any of the three methods outlined in Exercise 33, Series F, and test in duplicate by the Mann's test each of the lots of milk provided.
- B. With a pipette measure out 17.6 cc. of the milk to be tested into a white cup. Use a 100 cc. graduate containing the *Standard* Farrington Alkaline tablet solution, and continue adding small quantities of the solution to the milk until a faint pink color develops. Record the number of cc. of the solution used. The milk in the cup should be stirred continuously while the Farrington alkaline tablet solution is being added.
- C. Test each of the lots of milk provided by both of the above methods. All tests should be made in duplicate.

**Observations:**

| Test         |   | cc. sample | cc. solution | % acidity |
|--------------|---|------------|--------------|-----------|
| Mann's       | a |            |              |           |
|              | b |            |              |           |
| Farrington's | a |            |              |           |
|              | b |            |              |           |

**Conclusions:**

**Questions:** (1) What are the advantages and disadvantages of the Farrington Alkaline tablet solution and the NaOH solutions?

(2) What influence has the richness of cream on the acidity test?

(3) If a 40% fat cream contains .20% acidity, what is the acidity of the serum?

(4) If cream testing 25% fat has an acidity of .5%, what will be the "corresponding" acidity of cream testing 40% fat?

**References:** F. & W. ¶ 135-151, inclusive; Van S. pp. 131-151; Jud. pp. 102-111; St. pp. 132-136.

## EXERCISE NO. 35

**Object:** *To become acquainted with the preparation and use of the Farrington rapid method of acidity testing.*

**Procedure:** Milk which gives the highest acid test contains, as a rule, a larger number of bacteria and spores not destroyed by pasteurization than does milk giving a low acid test. (F. & W. ¶ 129.) It is therefore important that milk be properly selected at the receiving room in order to have the best material for manufacturing purposes, and any simple test which will aid in the proper selection is of immense value.

- A. The Farrington rapid method alkaline tablet solution for selecting milk containing less than .2% acid, is prepared by dissolving two Farrington alkaline tablets in one ounce of distilled water. This solution is ready for use after about 12 hours, or after all tablets have entirely disintegrated.

If, when equal amounts of this solution and milk are taken and mixed, the mixture turns pink, the per cent is below .2%. Conversely, if the mixture remains white, the acidity is above .2%.

- B. Test all samples provided, using the dippers and cups supplied.

Note: With a little practice in using fractional parts of a dipper of solution, the approximate acidity of a sample may be determined.

**Observations:**

| Sample | Approximate acidity |
|--------|---------------------|
| 1      |                     |
| 2      |                     |
| 3      |                     |

**Conclusions:**

**Questions:** (1) How is an NaOH solution, equal in strength to the Farrington rapid method solution, prepared?

(2) How is a Farrington alkaline tablet solution prepared so that it will indicate an acidity exceeding .25%?

(3) If 25 cc. of milk requires 5 cc. of an  $\frac{n}{5}$  NaOH solution for neutralization, what per cent of acidity does milk contain?

(4) If 20 cc. of an  $\frac{n}{9}$  NaOH solution is necessary to neutralize a 17.6 cc. sample of milk, what per cent acidity has it?

**References:** F. & W. ¶ 128–150, inclusive; Van S. pp. 131–151; Jud. pp. 102–111; St. pp. 132–136.

## SERIES G.

## Testing Milk for Casein.

**Materials** necessary for 10 students:

- \*1—Hart casein centrifuge (15" diameter, tubes extended).
- \*20—Hart casein test bottles.
  - 5—20 cc. pipettes.
  - 5—10 cc. pipettes.
  - 5—5 cc. pipettes.
  - 5—1 cc. pipettes.
- \*100 cc.—Chloroform.
- \*500 cc.—.25 % acetic acid solution (10 cc. glacial acetic acid diluted to 100 cc. with water; then diluting 25 cc. of this solution to 1000 cc).
  - 5—200 cc. flasks.
- \*500 cc.—Standard NaOH solution (795 cc.  $\frac{n}{10}$  NaOH solution plus distilled water to equal 1000 cc).
- \*25—Filter paper discs 6".
- \*500 cc.— $\frac{n}{9}$  NaOH solution.
- \*200 cc.—40 % formaldehyde (neutral).
- 3000 cc—Distilled water.
  - 5—4" glass funnels.

## EXERCISE NO. 36

**Object:** To become acquainted with the Hart Casein Test.

**Procedure:** The casein content of milk averages between 2.0 and 4.0%, and is equal to about 80% of the proteins present. Its percentage composition is approximately, carbon 53.0%; hydrogen 7.12%; nitrogen, 15.65%; oxygen, 22.6%; Sulphur, 0.78%; phosphorous, 0.85%. It forms about 20–25% of the total solids of milk. The ratio of casein to fat varies from 1:1.9 to 1:1.3.

Observe the table given below:

| Breed          | Authority          | Casein | Fat    |
|----------------|--------------------|--------|--------|
| Holstein.....  | Hart.....          | 1      | : 1.49 |
|                | Eckles & Shaw..... | 1      | : 1.31 |
| Ayrshire.....  | Hart.....          | 1      | : 1.44 |
|                | Eckles & Shaw..... | 1      | : 1.36 |
| Jersey .....   | Hart .....         | 1      | : 1.72 |
|                | Eckles & Shaw..... | 1      | : 1.69 |
| Guernsey.....  | Hart.....          | 1      | : 1.90 |
| Shorthorn..... | Eckles & Shaw..... | 1      | : 1.36 |

A. Test each of the lots of milk provided in duplicate as follows:

- (1) Measure 2 cc. (up to the 4 % mark) of chloroform into a Hart casein test bottle. Add 20cc. of the prepared .25 % acetic acid solution at room temperature. Add 5 cc. of the well mixed sample of milk. Hold thumb over opening of bottle and shake carefully for 20 seconds. Place bottles

in tester in pocket provided with corks and whirl for 8 minutes at a speed of 57 turns of crank per minute. (2000 R. P. M.) Place tests in rack for 10 minutes and then read results direct.

**B.** Make a fat test of the milk provided and compare the ratio of the casein to fat.

Note: All operations for the casein test should be as near 70° F. as possible.

**Observations:**

| Sample | % casein | % fat | Ratio 1 :? |
|--------|----------|-------|------------|
| 1      |          |       |            |
| 2      |          |       |            |

**Conclusions:**

**Questions:** (1) What is the condition of the casein in normal cow's milk?

(2) In what manufactured dairy product is casein one of the chief constituents? About what per cent?

(3) Give a formula and explain its use for determining the approximate protein and casein content of milk, when the lactometer is used.

(4) What are some of the commercial uses of casein?

**References:** F. & W. ¶ 257a, 258, 307; Van S. pp. 8-12, 199-200; St. pp. 318-321.

**EXERCISE NO. 37**

**Object:** *To become acquainted with Walker's Formaldehyde solution method of casein determination.*

**Procedure:** It is important that the formaldehyde used in this test be neutralized with alkali before using; i. e., it must have a distinct pink color to show that it is neutralized.

- A.** Test each of the lots of milk provided in duplicate as follows:
- (1) Pipette 10 cc. of a well mixed sample of milk into a porcelain cup, add 1 cc. of a one per cent solution of phenolphthalein; neutralize with an  $\frac{n}{9}$  NaOH solution, stirring constantly until a fairly permanent *deep* pink color develops.
  - (2) Add 2—3 cc. of natural 40% formaldehyde.
  - (3) Titrate with  $\frac{n}{9}$  NaOH solution until the same permanent deep color develops as before adding the neutral formaldehyde.
  - (4) The number of cc.  $\frac{n}{9}$  NaOH solution used for step 3 multiplied by 1.63 will give the per cent casein in the sample.
- B.** Make a fat test of the milk provided and compare the ratio of the casein to the fat.

**Observations:**

|   | Sample | % casein | % fat | Ratio 1 : ? |
|---|--------|----------|-------|-------------|
| 1 |        |          |       |             |
| 2 |        |          |       |             |

**Conclusions:**

- Questions:**
- (1) If you assume that 17.5 cc. of milk was used instead of 10 cc. what factor would you use?
  - (2) What factor would you use if you have an  $\frac{n}{10}$  normal solution instead of an  $\frac{n}{9}$  solution?
  - (3) How may casein be prepared commercially?
  - (4) What chemicals are used for precipitating casein?

**References:** F. & W. ¶ 18.

EXERCISE NO. 38

**Object:** *To become acquainted with Van Slyke's Volumetric method of casein determination.*

**Procedure:** The milk constituents which determine the yield of cheese are fat and casein. Since the casein in different milks does not increase in as great a ratio as the fat content, a problem arises as to the proper method of payment at cheese factories where milk having a wide range in fat content is sold. Several suggested methods are: Fat +2; Fat +.6; Fat +calculated casein.

A. Test each of the lots of milk provided in duplicate as follow:

- (1) Measure out 17.5 cc. of milk into a 200 cc. flask, and add 80 cc. of distilled water and 1 cc. phenolphthalein solution. Titrate carefully with a standard NaOH solution, shaking vigorously after each addition until just a permanent pink tinting of the milk is obtained.
- (2) Add standard acetic acid solution in 5 cc. quantities until 25 cc. have been added. Shake thoroughly after each addition. If the casein does not settle readily, add more acetic acid in quantities of 1 cc. and shake. Record the cc. of acetic acid use as "A."
- (3) Fill the flask with distilled water to the 200 cc. mark. Shake 10-15 seconds and filter through a dry filter into a dry cup. The filtrate should be clear.
- (4) Take 100 cc. of the filtrate and titrate carefully with a standard NaOH solution until a permanent pink color which will remain a half minute or so, is obtained. Record the cc. of the standard NaOH solution as "B."
- (5) Calculate the per cent casein in the milk by the following formula:

$$\frac{A}{2} - B = \% \text{ casein.}$$

B. Make a fat test of the milk provided and compare the ratio of the casein to the fat.

**Observations:**

| Sample | % Casein | % Fat | Ratio 1 : ? |
|--------|----------|-------|-------------|
| 1      |          |       |             |
| 2      |          |       |             |

**Conclusions:**

**Questions:** (1) How does the casein content of buttermilk and skimmilk compare with that of whey?

- (2) What effect has freezing on the physical and chemical properties of milk?
- (3) How does casein compare in food value with fat? With sugar?
- (4) What part of milk is albumen, and of what commercial value is it?

**References:** F. & W. ¶ 18, 23, 307; Van S. pp. 189-199.

## SERIES H

## TESTING BUTTER

**Materials** necessary for 10 students:

- 10— $\frac{1}{2}$  pint glass top fruit jars (*Ball Ideal*).
- \*10—*Farrington Butter fat test bottles*.
- 10—*Aluminum Beakers* (125 cc.).
- 10—4'' spatulas.
- 5—250 cc. volumetric flasks.
- 1—*Wisconsin high pressure oven*, or
- 5—*Alcohol lamps*, or
- 5—*Bunsen burners and Benkendorf ovens*.
- 25cc. — *Potassium Chromate* ( $K_2CrO_4$ ) solution (F. & W. ¶ 278).
- 200cc.—*Silver nitrate* ( $AgNO_3$ ) solution. (F. & W. ¶ 278.)
- 1—Kg. petroleum ether or high test gasoline (for ether extraction test).

## EXERCISE NO. 39

**Object:** *To become acquainted with the Farrington test for fat in butter.*

**Procedure:** The important step in testing butter as well as milk or cream is obtaining a correct sample. This is accomplished as follows when taken direct from the churn; bring butter up on table, wipe free moisture from above doors. Cut the top off butter with a ladle and with a spatula obtain a small sample (5–10 grams each) from at least 5 different places along the full length of the butter, and place in the half pint glass top fruit jars. Seal the jar. Care should be exercised to avoid having free water dropping into the jar.

If the sample is to be taken from a box, tub, or print, a trier should be used to obtain a representative sample. Do not shake trier to remove free water.

- A. Warm the butter so that it is in a semi liquid condition, at a temperature of about 100° F. Beat with a spatula until it has a uniform, creamy consistency. Avoid oiling off.
- B. Weigh a clean, empty, especially constructed Farrington butter fat bottle, and record its weight. Pour into the bottle enough of the prepared sample to bring to about the 47 gram mark, weigh again, and by subtracting the first weight from the last, obtain the weight of the butter and record it.
- C. Place the bottle in a hot water bath (160°+F.) for fifteen minutes remove to a Babcock centrifuge and whirl at top speed in a hot tester for fifteen minutes. Place in a hot water bath at 140° F. for 10 minutes and read quickly the top and bottom of the fat column. Obtain the net weight of the fat by subtracting the smaller reading from the larger.

D. Calculate the per cent fat as follows:

$$\frac{\text{Net reading}}{\text{grams butter in bottle}} \times 100 = \% \text{ fat.}$$

Note: A sharper dividing line may be obtained by dropping a small quantity of strong hot salt water through the fat after whirling.

Observations:

| Sample | Weight of Butter | Net Reading | % fat |
|--------|------------------|-------------|-------|
| 1      |                  |             |       |
| 2      |                  |             |       |

Conclusions:

- Questions:
- (1) Name four other fat tests which may be used for determining the fat content of butter.
  - (2) Why is the Babcock test not commonly used for determining the fat content of butter?
  - (3) How is the silver nitrate solution for the salt test, described in exercise 41, prepared?
  - (4) How is the indicator for the butter salt test prepared?

References: F. & W. ¶ 102–103d, inclusive, 278, 278a; Van S. pp. 112–130; Jud. p. 86.

**EXERCISE NO. 40**

**Object:** *To become acquainted with a factory test for moisture in butter.*

**Procedure:** Millions of dollars are lost annually by the creamery industry because of ununiform composition of butter.

- A. Warm the butter so that it becomes soft, but avoid oiling off. A temperature of 80°–100° F. will best accomplish this. Beat with a spatula until it has a uniform thick custard consistency. Weigh out exactly 10 grams into a clean dry aluminum dish which has been balanced on the right hand pan of a Torsion moisture test scale. When balancing the dish, the 1 and 2 gram weights should be kept at rest at the extreme left end of their respective riders.
- B. Place the dish containing the 10 grams of butter in a Wisconsin high pressure oven or hold over an alcohol flame, or place in a Benkendorf oven until all foam has disappeared and the butter has a brown appearance. Remove the dish and allow to cool in a dry place.
- C. Place dish on right hand pan of scale and move the two and one gram weights to the right until the scale again balances. The per cent moisture is read direct off the riders.
- D. Save the sample for Exercise 40 or 41.

Note: By using dishes of approximately equal weight and the small tare weight, a number of samples may be weighed out in succession on the same scale.

**Observations:**

| Sample | Weight | % Moisture |
|--------|--------|------------|
| 1      |        |            |
| 2      |        |            |

**Conclusion:**

**Questions:** (1) What is the legal standard for butter in this state? In the United States?

- (2) Give a brief description of each of the following methods of evaporating the moisture from butter: Patrick, Irish, Wisconsin high pressure oven, Benkendorf oven.
- (3) If a sample, while being prepared, is warmed to such an extent that it oils off, how should it be treated in order that a representative 10 grams of butter can be obtained?
- (4) Name several precautions that should be taken during the weighing and evaporating process.

**References:** F. & W. ¶ 272–277, inclusive; Van S. pp. 112–124.

**EXERCISE NO. 41**

(42 should be substituted at this point if the ether extraction test is to be made.)

**Object:** *To become acquainted with the salt test of butter.*

**Procedure:** In the average creamery where one man performs many duties, it is customary to make but one or two tests of butter; always the moisture and occasionally the salt test. It is assumed that average butter contains 1 % of curd, hence the fat content of the butter is approximated by difference as follows:

$$100 - (\% \text{ moisture} + \% \text{ salt} + 1) = \% \text{ fat.}$$

- A. If the moisture test has been made or if the ether extraction test (Exercise 42) has been made, the residue is used for the salt test. If neither has been made the sample is obtained and weighed out as for the moisture test.
- B. The fat, curd and salt mixture is transferred to a pint jar or bottle with 250 cc. of warm (110° F.) water, measured out in a 250 cc. volumetric flask. Mix thoroughly with a rotary motion and allow a few seconds for the fat to rise.
- C. Transfer 17.6 cc. of the mixture to a white cup. Hold finger over upper end of pipette while it is being inserted to prevent the entrance of fat.
- D. Add two drops of potassium chromate indicator and titrate with the prepared silver nitrate solution. 1 cc. of the solution indicates 1 % salt.

**Observations:**

| Sample | Weight | cc. Ag No <sub>3</sub> Solution | % Salt |
|--------|--------|---------------------------------|--------|
| 1      |        |                                 |        |
| 2      |        |                                 |        |

**Conclusions:**

**Questions:** (1) Give the chemical reactions taking place in the salt test. Use equations.

- (2) Why should the silver nitrate solution be kept in brown glass bottles?
- (3) What is the purpose of adding salt to butter?
- (4) Why does the amount of salt that can be incorporated in butter depend upon the moisture content of the butter?

**References:** F. & W. ¶ 278; Van S. pp. 125-130.

**EXERCISE NO. 42**

**Object:** *To become acquainted with the ether extraction method of fat determination of butter.*

Note: High test gasoline may be substituted for ether.

**Procedure:** "Attempts have been made to use the Babcock glassware and tester for the determination of fat in butter, but the results have not been entirely satisfactory, and only a fair degree of accuracy may be expected." (F. & W. ¶ 102-103.)

- A. Determine the moisture content of a sample of butter as outlined in Exercise 40. Use a rather narrow lipped aluminum beaker having a capacity of about 100 cc.
- B. After the breaker is weighed to determine the loss in moisture, fill with petroleum ether and stir with a glass rod. Cover with a watch crystal and allow to stand for 2 or 3 minutes to allow the curd and salt to settle. Decant off the solvent without disturbing the sediment. Fill with petroleum ether again and stir. Allow to settle. Decant off after a short time.

Best results will be obtained if both the ether or gasoline and fat are warm.

- C. Heat the beaker gently over hot plate, or water bath to drive off ether. Avoid sputtering due to overheating.
- D. Reweigh the beaker and determine the per cent fat by the difference in weight.
- E. Determine the salt content of the residue as in Exercise 41.

Note: The result for the curd will be slightly low and that for fat high due to a slight loss (about .2 per cent) in decanting off the ether fat mixture.

**Observations:**

| Sample | Weight | Weight of water | % water | Weight of fat | % fat |
|--------|--------|-----------------|---------|---------------|-------|
| 1      |        |                 |         |               |       |
| 2      |        |                 |         |               |       |

**Conclusions:**

- Questions:**
- (1) What is the average composition of American butter?
  - (2) What is the legal standard for butter in each of the four leading foreign butter producing countries?
  - (3) Name the five leading butter producing states in the U. S., and give the amount each produces.
  - (4) Name the four leading butter producing nations.

**References:** F. & W., p. 307; Van S. p. 16.

## SERIES I.

### Testing Cheese.

**Materials** necessary for 10 students:

- 5—5 gram weights.
- 5—9 or 10 gram weights.
- 5—2 gram weights.
- \*10—small tin evaporating dishes.
- 1—High pressure oven.

### EXERCISE NO. 43

**Object:** *To determine the fat content of cheese by using the Babcock test.*

**Procedure:** "It is important in testing cheese, just as in other dairy products that a correct sample be obtained. This is done as follows: Draw a plug from a sound portion of the cheese with a cheese trier; this should be taken at a point that is not near the rind, a cut surface of the cheese, a defective spot or an old trier hole. Cut off the top one-half inch of the trier plug and replace it in the trier hole to protect the cheese." (F. & W. ¶ 105.)

- A. Carefully weigh 9 or 10 grams of cheese into a 30% cream test bottle. The more finely divided the cheese when placed in the test bottle, the easier it will be to get the cheese into solution. Add from 10-15 cc. of hot water and allow the cheese to emulsify. Hold the bottle in a hot water bath to complete the emulsification if necessary. The addition of 2-3 cc. of sulfuric acid, and vigorous shaking from time to time will also aid in the emulsification. It is important, in order that satisfactory results be obtained, to have all cheese emulsified. When no more lumps are seen in the liquid add 17.5 cc. of sulfuric acid, and complete the test in the usual manner.
- B. Whirl in centrifuge as for milk.
- C. Read as for cream, and calculate the test by using the formula:

$$\frac{\text{Reading} \times 18}{\text{grams used}} = \% \text{ fat.}$$

Note: Add acid in small quantities as a large quantity at one time causes too intense action. Carefully wash down all cheese particles from the neck of the bottle before adding the acid.

**Observations:**

| Sample | Grams cheese | Reading | % fat | Condition | Color |
|--------|--------------|---------|-------|-----------|-------|
| 1      |              |         |       |           |       |
| 2      |              |         |       |           |       |

**Conclusion:**

- Questions:** (1) What is the legal standard for fat and moisture in American or cheddar cheese in this state.
- (2) Which breed, the Holstein or the Jersey on an average give the greater yield of cheese per 100 pounds of milk? Prove your answer.
- (3) How may the yield of cheese be calculated by means of the Babcock test and the lactometer?
- (4) What is the average composition of Holstein milk, Jersey milk, Guernsey milk, Ayrshire milk?

**References:** F. & W. 104, 105, 224, 307; Van S. pp. 6, 109; Jud. pp. 86-87; St. p. 316.

EXERCISE NO. 44

**Object:** *To become acquainted with the cheese moisture test.*

**Procedure:** Of all laws pertaining to the composition of cheese, the one regulating the moisture content is most rigidly enforced.

- A. Read carefully the instructions pertaining to testing the moisture content of butter (Series H, Exercise 40, part A). Obtain a representative sample of cheese and weigh out 10 grams in a tin or aluminum evaporating dish. Place dish in a Wisconsin high pressure oven and evaporate at a pressure of 30 pounds for 5 hours. Allow dish to cool and place on right hand pan of scale. Place a 2 gram weight on the pan with the dish. Slide the 2 gram weight on the beam to the right to a convenient point on the beam and then slide the 1 gram weight to the right until the pans balance. The 2 gram weight on the pan indicates 20%, and the reading on the beams is readily obtained. Adding the reading on the beams to 20% will give the per cent of moisture present.
- B. If a 5 gram sample of cheese is weighed out instead of a 10 gram sample, it is unnecessary to use the 2 gram weight on the pan. In that case the reading on the beam obviously has to be multiplied by 2 in order to give the per cent moisture.

Note: By using a set of weights or dishes of very nearly equal weight, a number of samples may be weighed out on the same scale in rapid succession by merely keeping a record of the position of the small tare weight on the short graduated beam.

**Observations:**

| Samples | Grams Sample | Weight after evaporating | % moisture |
|---------|--------------|--------------------------|------------|
| 1       |              |                          |            |
| 2       |              |                          |            |

**Conclusions:**

- Questions:** (1) Why is the butter moisture test not adaptable to cheese moisture testing?
- (2) How may the approximate yield of cheese be obtained from the fat test of milk?
  - (3) How may the yield of cheese be obtained from a casein and fat test?
  - (4) Name four suggested plans of paying for milk at the cheese factory and briefly illustrate each.

**References:** F. & W. ¶ 223, 224, 225, 242, 243, 244, 245, 285; Van S. pp. 259-261; St. pp. 317-318.

## SERIES J.

## Ice Cream Testing.

**Materials** necessary for 10 students:

500cc.—*Mixture of glacial acetic and concentrated hydrochloric acid, equal parts.*

10—125cc. *glass beakers.*

3—50 cc. *Burettes and stands.*

3—250 cc. *flasks.*

3—200 cc. *flasks.*

\*1—*Benkendorf 50 cc. sampler.*

3—*Glass funnels.*

3—1 cc. *pipettes.*

50 cc.—*Ether.*

## EXERCISE NO. 45

**Object:** *To test ice cream for fat in the Babcock tester, by means of the sulfuric acid method.*

**Procedure:** Great care should be exercised in obtaining a correct sample because of the large amount of foam usually present. Pouring the melted sample back and forth at least 10 times will usually eliminate most of the foam.

- A. Weigh out 9 grams of the melted ice cream into an 18 gram test bottle. Add 9 grams of luke warm water. At intervals of a minute or two add small quantities of sulfuric acid (sp. gr. 1.82–1.83). Shake well after each addition and continue adding until a chocolate brown color appears. Add at once a few cc. of cold water to check the action of the acid.
- B. Centrifuge as for milk except that two whirlings and one filling are sufficient.

Note: It may be advisable to check the action of the acid by cooling the mixture after each addition of acid by holding the test bottle for a short time in cold water.

**Observations:**

| Sample | Gram sample | cc. acid | Reading | % fat | Condition |
|--------|-------------|----------|---------|-------|-----------|
| 1      |             |          |         |       |           |
| 2      |             |          |         |       |           |

**Conclusions:**

**Questions:** (1) Why is the mixture not allowed to become hot as in testing cream?

(2) What is the Mojonnier tester for fat and solids, and of what established tests is it an adaptation?

(3) How may milk powder be tested for fat?

(4) What is the legal standard for ice cream in this state?

**References:** F. & W. ¶ 107, 108; Van S. pp. 95–100; Jud. pp. 87–88; St. p. 543.

**EXERCISE NO. 46**

**Object:** *To become acquainted with the Glacial Acetic and Hydrochloric Acid method for testing ice cream for fat in the Babcock test.*

**Procedure:** Laws differ in regard to ice cream, but agree in most cases on a fat standard. This may vary from as low as 6% as the minimum in some states, up to 14% as the minimum in other states.

- A. Weigh into an 18 gram test bottle 9 grams of thoroughly mixed ice cream. Add 20 cc. of the mixture of glacial acetic and hydrochloric acid as prepared under "materials required." Shake well and place the test bottle in a hot water bath until a brown color appears.
- B. Whirl in a Babcock centrifuge as for milk, and read as a cream test is read.

**Observations:**

| Sample | cc. sample | cc. acid | Reading | % fat | Condition |
|--------|------------|----------|---------|-------|-----------|
| 1      |            |          |         |       |           |
| 2      |            |          |         |       |           |

**Conclusions:**

**Questions:** (1) What is the average composition of commercial ice cream?

(2) What is meant by the term milk solids in ice cream? What ingredients are used to increase the milk solids?

(3) What is the average output in gallons of ice cream in the United States in one year? In this state?

(4) What is the per capita consumption of ice cream in the United States per year?

**References:** F. & W. 108; Van S. pp. 95-100.

**EXERCISE NO. 47**

**Object:** *To become acquainted with the Acetic and Sulfuric acid test for ice cream by using Babcock equipment.*

**Procedure:** For ice cream that contains chocolate and has been homogenized at a high pressure, it is very difficult to obtain a representative result with any of the methods described in this manual.

- A. Weigh out a 9 gram sample of thoroughly mixed ice cream into a 30% cream test bottle. Add 9 cc. of water to dilute the sample. Add 5 cc. of acetic acid and then add carefully 6-8 cc. of sulfuric acid (sp. gr. 1.82-1.83). Centrifuge and read as for cream. Multiply the reading by 2 if an 18 gram test bottle is used.

**Observations:**

| Sample | cc. sample | cc. acetic acid | cc. sulfuric acid | % fat | Condition |
|--------|------------|-----------------|-------------------|-------|-----------|
| 1      |            |                 |                   |       |           |
| 2      |            |                 |                   |       |           |

**Conclusions:**

**Questions:** (1) About how many pounds of milk are required to make one gallon of ice cream?

(2) What is the average composition of ice cream?

(3) If a 7 gram sample of ice cream gave a reading of 4.9 in an 18 gram bottle, what % fat did the ice cream contain?

(4) If a 12 gram sample of ice cream gave a reading of 15 in a 9 gram bottle, what % fat did the ice cream contain?

**References:** F. & W. ¶ 108; Van S. pp 95-100; Jud. pp 87-88.

**EXERCISE NO. 48**

**Object:** *To become acquainted with the Benkendorf test for over-run in ice cream.*

**Procedure:** There are now on the market a half dozen or more contrivances for determining the over-run of ice cream directly in the freezing room very rapidly, provided the weight of the "mix" before freezing is known, or if a sample of "mix" is kept on the over-run tester throughout the process. These contrivances are not adaptable for inspectors who desire to obtain the over-run of an already frozen mix which they know nothing about. For such, the Benkendorf test is used. It is based on the principal that when ice cream is melted, the volume of the ice cream will shrink to the original volume of the "mix."

- A. Take a 50 cc. ice cream sampler and immerse in the ice cream to be sampled. Allow it to remain there a short time to become thoroughly chilled. Withdraw the sampler, and with a spatula level both ends of the sampler. Transfer the sample to a 250 cc. flask by means of 200 cc. of hot water. This can be done by using a funnel. Shake with a rotary motion until all the ice cream is melted.
- B. By means of a burette containing hot water, the mixture can be brought up to the 250 cc. mark. To get rid of the foam add 1 or 2 cc. of ether. Water is again added to bring the mixture to exactly the 250 cc. mark.
- C. The number of cc.'s of water added from the burette plus the number of cc.'s of ether represents the shrinkage of the 50 cc. of ice cream. The calculations for determining the over-run are as follows:

Let A = the water and ether used in step C, and 50 (volume of sampler)— $A = B$ .

$$\frac{A}{B} \times 100 = \% \text{ over-run.}$$

B

Note: In order that no appreciable error be introduced, it is recommended that the 250 cc. flask be wetted and drained before transferring the ice cream, in order to compensate for the water adhering to the 200 cc. flask.

**Observations:**

| Sample | cc. water and ether used | 50—A | % over-run |
|--------|--------------------------|------|------------|
| 1      |                          |      |            |
| 2      |                          |      |            |

**Conclusions:**

- Questions:**
- (1) How may over-run in ice cream be calculated by weight?
  - (2) What is considered an average over-run in ice cream?
  - (3) What is modified milk, and what are its uses?
  - (4) What is the average output of malted milk in the United States in one year?

## SERIES K.

## Condensed Milk Testing.

**Materials** necessary for 10 students:

5—250 cc. flasks.

## EXERCISE NO. 49

**Object:** *To determine the fat content of unsweetened condensed milk by means of the Babcock test.*

**Procedure:** Due to the condition of the milk, the sugar that may be present, etc., it is very difficult to test condensed milk for fat.

The following method is, however, suggested for unsweetened condensed milk.

A. Exercise great care so as to obtain a representative sample from the can of milk. Dilute 25 cc. of condensed milk with 75 cc. of water, making 100 cc. Test as for whole milk, but fill the bottle after the first and second whirling with a hot mixture of acid and water 1 :1. Read as for milk.

B. Calculate the per cent fat as follows:

$$\frac{\text{Reading} \times 18}{4.4} = \% \text{ fat}$$

Note 1: In order to get a good sample, it may be necessary to heat the sample to 130° F. for 10 minutes, and then shake well before opening the cans.

Note 2: If sweetened condensed milk is to be tested the plan of Exercises 46 to 47 may be followed.

**Observations:**

| Sample | Reading | % fat | Condition |
|--------|---------|-------|-----------|
| 1      |         |       |           |
| 2      |         |       |           |

**Conclusions:**

**Questions:** (1) What is the government standard for condensed and evaporated milk?

(2) How many pounds of whole milk are necessary to manufacture one pound of condensed milk?

(3) Name the important uses of condensed milk.

(4) Why is it absolutely necessary to have a good quality sweet milk when it is to be condensed?

**References:** F. & W. ¶ 264; Van S. pp 95-100; Jud. pp 87-88.

EXERCISE NO. 50

**Object:** *To determine the specific gravity of condensed milk.*

**Procedure:** By knowing the fat tests and solids not fat of the milk entering into the manufacture of condensed milk, and then again testing the condensed milk for these constituents, it is possible to determine the concentration.

- A. Take 50 grams of thoroughly mixed condensed milk, weigh into a tared beaker, and wash with enough warm water into a flask to make exactly 250 cc. Cool to 60° F. and obtain the specific gravity with an accurate lactometer. Designate the reading expressed as specific gravity as “a.”
- B. Calculate the density of the condensed milk as follows:

$$\text{sp. gr. of condensed milk} = \frac{1}{6-5a}$$

- C. The concentration of the condensed milk, if the specific gravity and fat content of the original is known, is determined as follows:

$$\text{Concentration } (\dot{C}) = \frac{\text{as}}{a_1s_1}$$

a—solids not fat of condensed milk.  
s—specific gravity of condensed milk..  
a<sub>1</sub>—solids not fat of milk used.  
s<sub>1</sub>—specific gravity of milk used.

**Observations:**

| Sample | Sp. gravity of dilution | Sp. gravity of condensed milk, |
|--------|-------------------------|--------------------------------|
| 1      |                         |                                |
| 2      |                         |                                |

**Conclusions:**

- Questions:**
- (1) Give the four states leading in the manufacture of condensed and evaporated milk.
  - (2) What is the difference between condensed and sterilized milk?
  - (3) Why is sugar often added to condensed milk during its manufacture?
  - (4) What is the approximate difference in composition between ordinary condensed and sweetened condensed? Give figures.

**References:** F. & W. ¶ 264, 307.

## SERIES I.

## Quality Tests (Special)

**Materials** necessary for 10 students:

- 1—Sediment tester and cotton disks.
- 100—5" test tubes.
- 100 cc.—Methylene blue solution (1 part crystalline dye in 2000 parts water. Redilute just before use so that the concentration is 1 part dye to 20,000 parts of water).
- 300 cc.—ethyl alcohol solution (60% by weight: 68% by volume).
- 1—Incubator.
- \*1—Marschall rennet testing set.

## EXERCISE NO. 51

**Object:** *To become acquainted with the Wisconsin sediment test for milk.*

**Procedure:** Aside from a knowledge of the fat content and the acidity of the milk, it is highly important that some test be used whereby the consumer or manufacturer may establish the care that the milk has been given in regard to cleanliness. For this purpose the sediment test is widely made use of by city milk plants, cheese factories and condenseries.

- A. Place a specially prepared cotton disk on the wire screen of the sediment tester and force one pint of the milk to be tested through the cotton disk. Paste the disk on one of the cards provided and hand in with the exercise.

**Observations:**

**Conclusions:**

- Questions:**
- (1) Outline how a farmer may produce milk with a good sediment test.
  - (2) What is the result when dirty milk is used for cheesemaking?
  - (3) What is a milk clarifier and how is it used.
  - (4) Is a good sediment test always an indication that the milk is good? Explain your answer fully.

**References:** F. & W. ¶ 298; Van S. pp 163-168; St. pp 144-145.

EXERCISE NO. 52

**Object:** *To become acquainted with the Methylene blue reduction test and the Fermentation test of milk.*

**Procedure:** The fermentation test and the Methylene blue test may be performed separately as an individual test or they may be combined as one test. The tests are of greatest value to the cheese maker to detect abnormal fermentations. They may be used by the buttermaker as well to locate off-flavors. They are of greatest value when combined with the acidity test for then they will give a clue to the kind of organisms present. The aim of the Methylene blue test is to place the milk into certain defined grades which may be tabulated somewhat as below. The number of organisms, of course, is relative and is given merely as a matter of interest.

| Grade | White after     | Organisms            |
|-------|-----------------|----------------------|
| 1     | 5½ hrs.         | 0-500,000            |
| 2     | 2-5½ hrs.       | 500,000-4,000,000    |
| 3     | ⅓-2 hrs.        | 4,000,000-20,000,000 |
| 4     | Less than ⅓ hr. | 20,000,000-upward    |

- A. Wash and clean five test tubes. Sterilize by placing in a wire basket and placing under a pail which has been inverted over a steam jet. The steam is then turned on for a period of 15 minutes. If no steam is available the test tubes may be placed in boiling water for 10 minutes.
- B. Use one test tube for each patron. Catch the milk in the test tube directly out of the patron's can while the can is being dumped. Add 1 cc. of Methylene blue solution to each test tube and mix. Place the test tube in an incubator at 98° F. Observe after hourly intervals and record the color of the milk. Compare with the table above.
- C. If the test tubes are left in the incubator for 24 hours and their appearance noted it will be possible to determine to what class of organism the reduction was due. The appearance of the milk in the test tubes is also indicative of the quality of cheese which it will make. The fermentation test may be made independent of the Methylene blue test.

**Observations:**

| Sample | Acidity | Reduction time | Fermentation | Grade |
|--------|---------|----------------|--------------|-------|
| 1      |         |                |              |       |
| 2      |         |                |              |       |
| 3      |         |                |              |       |
| 4      |         |                |              |       |
| 5      |         |                |              |       |

**Conclusions:**

**Questions:** (1) Give a brief description of the Wisconsin curd test.

(2) How should milking machines be cleaned in order to produce a good grade of milk?

(3) What is certified milk?

(4) Describe several types of milk and cream coolers.

**References:** F. & W. ¶ 153 to 158, inclusive; Van S. p. 163.

EXERCISE NO. 53

**Object:** *To become acquainted with the alcohol test for quality of milk.*

**Procedure:** It has been claimed that the alcohol test is a better indication of the suitability of milk for condensing than the acidity test.

- A. The alcohol solution is prepared by using ethyl alcohol, diluted with distilled water so that it contains 60 % by weight or 68 % by volume of ethyl (grain) alcohol.
- B. The test is made by using a clean small test tube and filling about one-third of the milk to be tested. An equal quantity of the above alcohol solution is added and mixed. After mixing, the tube should be slowly raised to a vertical position. White flakes on the glass indicate a strong degree of acidity. A slight film indicates a slight degree of acidity. A clear glass indicates a low degree of acidity.
- C. Test the milk provided by means of Mann’s acidity test and compare with tests of the same milk made with the alcohol solution.

**Observations:**

| Sample | % Acidity | Condition with alcohol test |
|--------|-----------|-----------------------------|
| 1      |           |                             |
| 2      |           |                             |
| 3      |           |                             |

**Conclusions:**

- Questions:** (1) How much light and ventilation should be provided for each cow when a stable is being constructed?
- (2) How should a milk house be constructed and where should it be located?
  - (3) Why are partly covered pails superior to the open top pail?
  - (4) Why should turnips, ruta-bagas, silage, etc., not be fed during the milking period?

**References:** F. & W. ¶ 152–158; Van S. pp. 153–154.

**EXERCISE NO. 54**

**Object:** *To become acquainted with the Marschall rennet test.*

**Procedure:** The rennet test is used by cheesemakers to determine the ripeness of the milk. It is claimed that rennet tests are more sensitive to acidity during the early phases of acid development than the acid tests, and hence are to be preferred by cheese makers.

- A. Fill the small glass with pure water to the mark and pour into it 1 cc. of rennet extract. Rinse the pipette with the same water.
- B. Fill the cup with milk to the zero mark, add rennet, mix thoroughly and allow to stand.
- C. Milk will flow from the cup until coagulated. The scale on the inside of the cup shows directly the time necessary for coagulation. The sweeter the milk, the more will flow from the cup.

Note: For cheese making the correct degree of acidity is from 0.19–0.21 %, or when the milk coagulates at 2½ spaces Marschall rennet test, and rennet should be added at that time.

**Observations:**

**Conclusions:**

**Questions:** (1) Describe the Monrad rennet test.

- (2) What is rennet extract, and how is it obtained?
- (3) Why is it important that milk develop the proper degree of acid when making cheese?
- (4) What is the object of adding rennet extract to milk when making cheese?

**References:** F. & W. ¶ 157, 158; Jud. pp. 238–241; St. pp. 304–306.

# PART II—MANUFACTURE OF DAIRY PRODUCTS

## SERIES A.

### Butter.

**Materials** necessary for 10 students:

- 1—Hand or small power churn.*
- Sufficient cream to fill churn one-third full.*
- 1—Acidity testing outfit.*
- 4—Pails.*
- 2—20 gallon cans.*
- 50cc.—Butter color.*
- 10—Pounds butter salt.*
- Sufficient cold water (under 58° F..)*
- 2—Ladles.*
- Several tubs fully lined.*
- 1—Worker if hand churn is used.*

### EXERCISE NO. 1

**Object:** *To become acquainted with the manufacture of Dairy Butter.*

**Procedure:** Buttermaking is a science and to make good butter is an art.

Without study and practice, no one can make good butter, but above all things the greatest asset is the best kind of cream.

A. Careful observation and adherence to the following points will aid immensely in producing high grade butter.

- (1) Milk utensils and separator should be thoroughly washed and scalded after use. Sunlight is the best drying agent and an excellent disinfectant.
- (2) Set the separator so that it skims a cream testing 30–35% fat.
- (3) Cool cream rapidly after skimming to 50° F. or below.
- (4) Do not mix fresh cream with cream from a previous skimming until both have the same temperature.
- (5) Aim to have the cream of the same acidity at every churning in order to produce butter of a uniform quality. On the farm, temperature is the controlling agency. Immediate cooling to a low temperature will result in low acidity. Warming cream to 65–75° F. and holding at that temperature will tend to increase the acidity. Do not guess. Test.
- (6) Hold the cream at churning temperature or below for at least two hours before churning.
- (7) Wash the churn, ladles, butter worker, and all churning utensils; scald with hot water, and finally cool with plenty of cold water to a temperature below the churning temperature.
- (8) Strain the cream into the churn. See that the churn is not over one-half full.

- (9) Add enough butter color to give the butter the same shade of yellow that it has in the summer months. (The amount of color varies from 10-40 cc. per 100 pounds of fat.)
- (10) Revolve the churn at such a speed that the cream pounds hard against the sides of the churn (30-50 R. P. M.), open vent plug several times during the first 50 or 75 revolutions to allow gas to escape. Stop churning when the granules are the size of cracked corn.
- (11) Drain out the buttermilk using a strainer to catch any particles of butter.
- (12) Wash the butter with about the same amount of water as there was cream in the churn and at a temperature a few degrees below that of the buttermilk. Revolve the churn 5 or 6 revolutions. Drain out wash water, and repeat if necessary.
- (13) If a hand churn is used remove the granular butter to the rinsed worker and distribute the salt evenly at the rate of  $\frac{1}{2}$ -1 oz. per pound of butter fat. In the power churn a trench is made and the dampened salt is distributed evenly in the trench.
- (14) Work the butter until it is waxy and no longer gritty.
- (15) Pack the butter in suitable containers.
- (16) Clean the churn and utensils.

**Observations:**

|                                                                                     |  |
|-------------------------------------------------------------------------------------|--|
| Weight of cream . . . . .                                                           |  |
| Test of cream . . . . .                                                             |  |
| Pounds butter fat in cream . . . . .                                                |  |
| Pounds butter made . . . . .                                                        |  |
| % over-run $\left(\frac{\text{Butter-fat}}{\text{Fat}} \times 100\right)$ . . . . . |  |
| Acidity of cream . . . . .                                                          |  |
| Temperature of cream . . . . .                                                      |  |
| Time to churn . . . . .                                                             |  |
| Size of granules . . . . .                                                          |  |
| Temperature of buttermilk . . . . .                                                 |  |
| Temperature of wash water . . . . .                                                 |  |
| Amount of salt . . . . .                                                            |  |
| Rate of salt . . . . .                                                              |  |
| Pounds of buttermilk . . . . .                                                      |  |
| Test of buttermilk . . . . .                                                        |  |

## Conclusions:

**Questions:** (1) Give 5 reasons for difficult churning on the farm.

- (2) What is the effect on the butter if cream is churned too warm, or if the wash water is too warm?
- (3) What is meant by the term "ripening" and why is cream ripened?
- (4) What advantages has creamery butter making over farm butter making?

**References:** Jud. pp. 193–215; St. pp. 235–288, 396–418.

EXERCISE NO. 2

**Object:** *To determine the influence of temperature of cream on the time of churning, the test of the buttermilk, and the quality of the butter.*

**Procedure:** The temperature of the cream is one of the most important factors determining the ease with which the cream churns. Any conditions which tend to make churning difficult call for an increase in the churning temperature. Any conditions, on the other hand, which tend to hasten the churning process, call for a decrease in the churning temperature. Generally the range for churning temperature is between 48°-60° F.

- A. Divide a lot of cream into two equal parts. Hold one lot at a temperature of 60° F. for 2 hours, and the other lot at 50° or 52° F. for 2 hours.
- B. Churn each lot of cream under the same conditions following the method outlined for Exercise 1.
- C. Record the time of churning for each lot, make a test of the butter milk, and set aside a print of butter of each lot for hardening and scoring.

**Observations:**

| Sample | Churning temperature | Time of Churning | Test of Buttermilk | Quality of Butter |
|--------|----------------------|------------------|--------------------|-------------------|
| 1      |                      |                  |                    |                   |
| 2      |                      |                  |                    |                   |

**Conclusions:**

- Questions:** (1) In addition to the effect on the buttermilk test, the body and time of churning, give three other effects of high or low churning temperature.
- (2) Name four factors aside from temperature that effect the hardness of fat.
  - (3) Why should cream be strained into the churn?
  - (4) Why is color added to cream? What is the nature of butter color?

**References:** Jud. pp 193-215; St. pp 235-288, 396-418.

**EXERCISE NO. 3**

**Object:** *To determine the effect of acidity on the time required to churn, on the test of the buttermilk and on the quality of the butter.*

**Procedure:** Sweet cream is viscous or sticky, but the acid in cream seems to reduce the viscosity although the cream becomes thicker.

- A. Divide a lot of sweet cream into two equal parts. Keep one part sweet by holding it at a low temperature. Ripen the other part at 70°-75° F. until it contains approximately .20% more acid than the sweet cream—then cool to the same temperature as the sweet cream and hold at that temperature for 2 hours.
- B. Churn both lots of cream under the same conditions and temperature.
- C. Record the length of time required to churn, and the test of the buttermilk. Set aside a print of butter from each lot for determining the quality of the butter.

**Observations:**

| Sample | Acidity | Churning Temperature | Time of Churning | Test of Buttermilk | Quality of the butter |
|--------|---------|----------------------|------------------|--------------------|-----------------------|
| 1      |         |                      |                  |                    |                       |
| 2      |         |                      |                  |                    |                       |

**Conclusions:**

**Questions:** (1) What is meant by pasteurization, and what are the objects of pasteurizing cream for buttermaking?

(2) What are the causes of mottles in butter?

(3) What are the causes of a greasy body in butter?

(4) What is the cause of a leaky body in butter?

**References:** Jud. pp 193-215; St. pp 235-288, 396-418.

## SERIES B.

### Cheese

**Materials** necessary for 10 students:

- 6 ---12-quart dairy pails.
- 1---400 pound vat.
- 500 cc.---Rennet extract.
- 1---Acidity testing outfit.
- 5 lbs.---Cheese salt.
- 1---Curd mill.
- 3---Cheese hoops.

### EXERCISE NO. 4

**Object:** *To become acquainted with the making of cottage cheese.*

**Procedure:** There are several ways of classifying the 3-400 kinds of cheese made in the world, namely:

- (1) Rennet.
  - (a) American.
  - (b) Swiss.
  - (c) Brick.
  - (d) Limburger, etc.
- (2) Non-Rennet.
  - (a) Cottage.
  - (b) Neufchatel.
  - (c) Hand cheese
  - (d) Sap-sago, etc.
- A. second classification.
  - (1) Ripened.
    - (a) Mold ripened.
      - (1) Roqueford (France).
      - Camembert (France).
      - (3) Brie (France).
      - (4) Gorgonzola (Italy).
      - (5) Stilton (England).
    - (b) Bacteria ripened.
      - (1) American.
      - (2) Swiss.
      - (3) Brick.
      - (4) Edam (Belgium).
      - (5) Gouda (Holland).
  - (2) Unripened.
    - (a) Cottage.
    - (b) Neufchatel.
    - (c) Cream.
- A. Twenty pounds of skim milk are weighed into a clean pail. About 20% of lactic starter (sour milk) is added, and the mixture heated to about 95°-105° F. and left in a warm place to sour and thicken. The time required for thickening varies in accordance with the quantity of starter added or the temperature held at.

- B. When thick, the sour milk is stirred gently with a thermometer or other fine instrument to break the curd up into large lumps, not into fine grains or smooth pulp. While stirring, apply heat by setting the material on the stove or in hot water until the temperature reaches 110°–120° F.
- C. Stop heating and stir occasionally for a period of one-half hour or more. This will result in shrinking of the curd. When it has shrunk so that it will settle down about two-thirds or three-fourths of the way to the bottom under the whey, the whey should be removed.
- D. Pour the whey and curd from the pail into a cheese cloth bag and allow to drain. As long as the curd remains warm it becomes drier and firmer. If there is danger of becoming too dry, cold water may be poured over the curd and the cloth then hung up to drain.
- E. When drained properly, 1–2% salt is weighed out and mixed with the curd. About 13–20 pounds of cottage cheese per 100 pounds of skim milk are obtained.

#### Observations:

|                          |   |   |   |   |   |   |   |   |   |       |
|--------------------------|---|---|---|---|---|---|---|---|---|-------|
| Pounds milk              | . | . | . | . | . | . | . | . | . | ..... |
| Acidity                  | . | . | . | . | . | . | . | . | . | ..... |
| % starter added          | . | . | . | . | . | . | . | . | . | ..... |
| Temperature at which set | . | . | . | . | . | . | . | . | . | ..... |
| Time before thickened    | . | . | . | . | . | . | . | . | . | ..... |
| Heating temperature      | . | . | . | . | . | . | . | . | . | ..... |
| Time held hot            | . | . | . | . | . | . | . | . | . | ..... |
| Pounds cheese            | . | . | . | . | . | . | . | . | . | ..... |
| % salt                   | . | . | . | . | . | . | . | . | . | ..... |

#### Conclusions:

- Questions:** (1) What are the causes of acid flavors in cottage cheese and what are the remedies?
- (2) What are the causes of dry and mealy textures and what are the remedies?
- (3) What are the causes of lumpy textures and what are the remedies?
- (4) Describe in what respects the process would differ, if cottage cheese were made in larger quantities?

**References:** Jud. pp. 236–249; St. pp. 289–390, 419–451.

## EXERCISE NO. 5

**Object:** *To become acquainted with the process of manufacturing American cheese.*

**Procedure:** In Wisconsin there are four distinct types of cheese made. The American (often called cheddar, or full cream), Swiss, Brick, and Limburger. The American cheese is made from partially ripened milk and is usually "set" at a temperature of about 86° F. and about 3-3½ oz. of rennet is used per 1000 pounds of milk. The Swiss and Limburger cheese require perfectly sweet milk and therefore a higher setting temperature (about 94° F.) and more rennet (about 4 oz. per 1000 pounds) is necessary. In American cheese the milk is heated to 102° F. or thereabouts to get it dry and firm. Limburger is heated to 96° F. to leave it moist. Brick cheese is somewhat intermediate and is heated to about 110°-112° F. to get it dry. In order to get the proper texture and "eyes" in Swiss cheese, the milk is heated from 128°-136° F. to get the curd dry.

Brick, Limburger, and Swiss cheese are salted from the outside, while the salt is mixed with the curd for American cheese. Brick or Limburger cheese is ready to eat in four to six weeks, Swiss in four to six months, and American cheese in one to six months.

- A. Place 200 pounds of good sweet milk in a cheese vat provided with a jacket for heating or cooling, then proceed as follows:
- (1) Heat the milk to 86° F. and make an acidity test. If the acidity is less than .19% it may be increased by holding at 86° F. for some time or by the addition of good starter (sour milk).
  - (2) Add color at the rate of ½-3 oz. per 1000 pounds milk. Dilute color with water before adding to milk. Mix milk and color thoroughly.
  - (3) Add rennet when milk has the proper degree of acidity. The amount varies from 2½-4 oz. per 1000 pounds of milk depending on acidity, temperature and composition of milk or strength of rennet. Dilute rennet with water (40 parts water to 1 part rennet) before adding. Mix thoroughly.
  - (4) When the curd is sufficiently firm, it should be cut into ¾-½ inch cubes as follows: lengthwise with a horizontal knife, crosswise with a perpendicular wire knife and lengthwise with a perpendicular knife.
  - (5) Heat the curd to express the whey to about 100° F. The acidity of the whey should be .16-.18%.
  - (6) Draw off the whey and gather the curd in a shallow layer on either side of the vat.
  - (7) Cut curd into blocks 6-8" wide when sufficiently firm. Turn the blocks over frequently to prevent cooling off too rapidly on one side.
  - (8) Mill the curd when of proper texture.

- (9) Salt the curd at the rate of  $1\frac{1}{2}$ – $2\frac{1}{2}$  pounds to each 1000 pounds of milk.
- (10) Place curd in hoops and press.

Note: The above are given only as a guide and not as detailed instruction.

**Observations:** Give the time necessary for each step, and give results of various tests made.

**Conclusions:**

- Questions:** (1) Give the approximate production of cheese by the four leading cheese states of the United States.
- (2) What is the average composition of American cheese?
  - (3) Name the kinds of American cheese which are commonly found on the market and give their approximate weight.
  - (4) Why is cheese paraffined a few days after removing from the press?

**References:** Jud. pp. 236–249; St. pp. 289–390, 419–451.

## SERIES C.

## Ice Cream.

**Materials** necessary for 10 students:

1—1 gallon ice cream freezer (hand power). *Materials to make  $\frac{1}{2}$  gallon "mix" in the proportion of any of the "mixes" given in the exercise.*

75 lbs.—Ice.

15 lbs.—Coarse salt.

1—Thermometer.

1—Pail.

1—Large spoon.

Hot water.

## EXERCISE NO. 6

**Object:** *To become acquainted with the manufacture of ice cream.*

**Procedure:** To make ice cream commercially involves expensive equipment and considerable knowledge regarding the proper preparation of "mixes." This exercise will take up the preparation of ice cream for the home, but under *observations*, data applicable to the commercial manufacture of ice cream will be called for.

A. Ice cream may be defined as a frozen product made from cream, sugar, with or without flavoring and filler. A common classification of ice cream is as follows:

- (1) Plain ice cream.
- (2) French ice cream or pudding (contains eggs and is usually cooked before freezing).
- (3) Fruit and nut ice cream. (Plain ice cream with fruit or nuts added after freezing).
- (4) Bisque ice cream. (Plain ice cream with ground up cookies or cake).
- (5) Mousse. (Whipped cream heavily flavored with candied fruits and nuts and hardened in a packer).
- (6) Sherberts or water ices.

B. Some basic recipes for approximately  $2\frac{1}{2}$  gallons of frozen ice cream.

Plain ice cream:

- $1\frac{3}{4}$  gal. 18% cream.
- 2 pounds sugar.
- 1 oz. vanilla extract.
- 2 oz. gelatine or  $\frac{1}{2}$  oz. ice cream powder.

Formula for French ice cream:

- $1\frac{1}{2}$  gal. 18% cream.
- 2 pounds sugar.
- 6 eggs (whites and yolks beaten separately).
- 1 oz. vanilla.

All may be cooked and cooled before freezing.

C. Freezing the ice cream.

- (1) Cool mixture to below  $40^{\circ}$  F. The freezer may be turned slowly at first to cool the mix.

- (2) Use finely crushed ice and coarse salt (5:1).
- (3) When the mix is well chilled, turn the freezer as rapidly as possible to whip in air and to obtain a smooth consistency. When the ice cream has the consistency of thick gravy, the dasher should be removed, fresh salt and ice packed around and over the can, and set aside to harden. In two hours it will be ready to serve.

Observations: Composition of mix.

| Materials used |        | Fat | Total solids |
|----------------|--------|-----|--------------|
| Kind           | Weight |     |              |
|                |        |     |              |
|                |        |     |              |
|                |        |     |              |
|                |        |     |              |
|                |        |     |              |
|                |        |     |              |
|                |        |     |              |
|                |        |     |              |
| Totals         |        |     |              |

Method of preparing the mix:  
Pasteurizing temperature . . . . .Time.....  
Homogenizing temperature. . . . .Pressure.....  
Emulsifying temperature . . . . .  
Aging:  
Temperature . . . . .Time.....  
Freezing:  
Temperature of mix . . . . .  
Temperature of brine . . . . .  
Time to freeze . . . . .  
Over-run . . . . .

Conclusions:

- Questions: Define what is meant by the terms “body” and “texture” of ice cream. How may each of these be obtained?
- (2) What is the purpose of producing swell or over-run in ice cream? What factors affect the over-run?
  - (3) Why is the speed of the ice cream freezer important?
  - (4) Name 8 dairy products that are used in commercial ice cream mixes.

References: Jud. pp. 216-235; St. pp. 511-546.

**SERIES D.****Hand Separators.**

**Materials** necessary for 10 students:

2—*Hand separators.*

6—*Pails.*

60-80—*Pounds of milk for each of last 5 exercises.*

**EXERCISE NO. 7**

**Object:** *To become acquainted with the principle and construction of a cream separator.*

**Procedure:** The principle upon which the centrifugal cream separator is based is the fact that the fat of milk has a specific gravity of approximately .90 and is found in the serum (sp. gr. 1.04) as an emulsion. As centrifugal force is applied to the milk in a separator bowl, the milk is divided into three parts: namely, the heavier part, composed of the heaviest portions of the milk, albuminoids, ash, sediment, germs, etc., and is commonly known as "slime;" the second layer, or next heaviest part is the skimmilk, and likewise makes its way to the outside of the bowl as a result of centrifugal force. The lightest part or cream is crowded to the center of the bowl by the heavier skim milk. There is no clear line of demarcation between the skimmilk and cream, since separation is continually taking place, but the richest cream is always found nearest the center of the bowl. The skimmilk nearest the outside of the bowl contains the least fat and therefore the separator bowls are so constructed that the skimmilk is carried off from the outside layer.

- A. Become familiar with each of the separators provided, by assembling, operating, handling, etc. Free use should be made of the instruction books.

**Observations:**

|                                   | 1 | 2 | 3 | 4 | 5 |
|-----------------------------------|---|---|---|---|---|
| Name of separator                 |   |   |   |   |   |
| Size by number                    |   |   |   |   |   |
| Capacity                          |   |   |   |   |   |
| Height                            |   |   |   |   |   |
| Appearance                        |   |   |   |   |   |
| Driving mechanism                 |   |   |   |   |   |
| Gears                             |   |   |   |   |   |
| Oiling system                     |   |   |   |   |   |
| Washable parts                    |   |   |   |   |   |
| Bowl type                         |   |   |   |   |   |
| Bowl—number of parts              |   |   |   |   |   |
| Time to wash                      |   |   |   |   |   |
| Ease of washing                   |   |   |   |   |   |
| Adjustments                       |   |   |   |   |   |
| Speed                             |   |   |   |   |   |
| Ease of assembling                |   |   |   |   |   |
| Ease of replacement of worn parts |   |   |   |   |   |

**Conclusions:**

- Questions;** (1) Make a detailed sketch of a separate bowl, using arrows and different colored inks to indicate the flow and separation of the milk.
- (2) Outline briefly the early history of the centrifugal cream separator.
- (3) Name the three methods of gravity separation of cream from milk. Give figures to indicate the completeness of separation.
- (4) What are the advantages of centrifugal separation of cream from milk over the gravity methods?

**References:** Jud. pp. 180-192; St. pp. 224-236.

**EXERCISE NO. 8**

**Object:** *To determine the capacity and efficiency of a centrifugal cream separator.*

**Procedure:** A cream separator is a delicate machine and should be given careful attention. The machine should be well oiled, better too much than not enough. A separator, damaged because of lack of oil, will never run the same again. The proper grade of oil should be selected. The bowl of a separator is its most important part and should be treated as such. Immersing in boiling water or steaming after washing, and then placing out to dry will prevent rust. The bowl should not be rinsed before washing with scalding water since this tends to bake the albuminoids on the bowl parts. The separator should be washed after every skimming. If the separator is not to be used for any length of time, all of the washable parts should be oiled to prevent rust.

- A. Every student should be assigned to a specific duty. Since there are 5 skimming exercises, the assignment allowing 5 to a separator may be as follows:
- (1) Foreman: Supervision of performance of experiment, assembling and operation of the separator.
  - (2) Operator: Assembles bowl; oils machine; operates the machine; disassembles machine, washes pails and utensils.
  - (3) Assistant operator: Flushes the bowl, times the operation, pours in the milk; washes the machine.
  - (4) Floor man: Obtains, weighs, and warms the milk; cleans floor; takes samples to tester.
  - (5) Tester: Makes all tests necessary for the experiment.
- B. (1) Warm 20 pounds of milk to 90° F.
- (2) Assemble machine properly and operate at correct speed.
  - (3) Flush bowl with one quart of luke warm water.
  - (4) Turn on milk and take the time of skimming.
  - (5) Flush the bowl at the end of the run.
  - (6) Weigh the skimmilk and cream.
  - (7) Test the skimmilk and cream.

| Observations: Machine.....                 | No.....             | Capacity..... |
|--------------------------------------------|---------------------|---------------|
| 1. Weight of milk . . . . .                |                     |               |
| 2. Test of milk . . . . .                  |                     |               |
| 3. Pounds of fat . . . . .                 |                     |               |
| 4. Pounds of cream . . . . .               |                     |               |
| 5. Test of cream . . . . .                 |                     |               |
| 6. Pounds of fat in cream . . . . .        |                     |               |
| 7. Pounds of skimmilk . . . . .            |                     |               |
| 8. Test of skimmilk . . . . .              |                     |               |
| 9. Pounds of fat in skimmilk . . . . .     |                     |               |
| 10. Fat unaccounted for 3—(6+9) . . . . .  |                     |               |
|                                            | $4 \times 100$      |               |
| 11. Per cent cream is of milk——— . . . . . | 1                   |               |
| 12. Length of test in minutes . . . . .    |                     |               |
|                                            | $(4 + 7) \times 60$ |               |
| 13. Capacity——— . . . . .                  | 12                  |               |
| 14. Speed of bowl . . . . .                |                     |               |
| 15. Temperature of milk . . . . .          |                     |               |

Conclusions:

- Questions: (1) Give four advantages to the patron for skimming a rich cream.
- (2) Give six advantages to the butter maker if the patrons deliver a rich cream.
- (3) Why should the parts of a separator bowl not be assembled until ready for use?
- (4) Give at least three reasons why it is a good idea to flush the separator bowl before starting to skim.

References: Jud. pp. 180–192; St. pp. 224–236.

EXERCISE NO. 9

**Object:** *To determine the effect of the temperature of the milk on the efficiency of separation, and on the amounts of cream and skimmilk, and the test.*

**Procedure:** In purchasing a separator, the following points should be considered:

- (1) Number of cows.
- (2) Capacity of the separator.
- (3) Efficiency of skimming.
- (4) Simplicity or ease of cleaning.
- (5) Durability.
- (6) Convenience of obtaining repairs.
- (7) Power to operate.
- (8) Ability of skimming a rich cream without high fat losses.
- (9) Price.
- (10) Ease of oiling—amount of oil needed.
- (11) General construction to promote cleanliness.

A. Obtain 30 or 40 pounds of milk and divide it into equal parts. Skim one part at a temperature of 90° F., flush bowl, and skim the second part at a temperature of about 60° F. Follow the instruction of Exercise 8 for skimming.

Note: The class should be shifted so that every member has a new position.

| Observations: | Machine.....              | No..... | Capacity..... |
|---------------|---------------------------|---------|---------------|
| (1)           | Weight of milk            | .       | .             |
| (2)           | Test of milk              | .       | .             |
| (3)           | Pounds of fat             | .       | .             |
| (4)           | Pounds of cream           | .       | .             |
| (5)           | Test of cream             | .       | .             |
| (6)           | Pounds of fat in cream    | .       | .             |
| (7)           | Pounds of skimmilk        | .       | .             |
| (8)           | Test of skimmilk          | .       | .             |
| (9)           | Pounds of fat in skimmilk | .       | .             |
| (10)          | Fat unaccounted for       | .       | .             |
| (11)          | Per cent cream is of milk | .       | .             |
| (12)          | Length of test in minutes | .       | .             |
| (13)          | Capacity                  | .       | .             |
| (14)          | Speed of bowl             | .       | .             |
| (15)          | Temperature of milk       | .       | .             |

Conclusions:

- Questions:**
- (1) How should a separator be washed in order to assure a good quality of cream?
  - (2) What is the effect on the strain of a separator bowl if the speed is doubled? If the diameter is doubled?
  - (3) How should cream be cooled in order to insure a good quality?
  - (4) Describe the construction of a typical cream cooling tank.

**References:** Jud. pp 180-192; St. pp 224-236.

**EXERCISE NO. 10**

**Object:** *To determine the effect of speed of the bowl on the efficiency of separation and the relative quantity of cream and skimmilk, and the test.*

**Procedure:** The composition of the separator "slime" according to Fleischmann is as follows:

|                               |        |
|-------------------------------|--------|
| Water.....                    | 67.3%  |
| Fat.....                      | 1.1%   |
| Gaseous matter.....           | 25.9%  |
| Other organic substances..... | 2.1%   |
| Ash.....                      | 3.6%   |
|                               | <hr/>  |
|                               | 100.0% |

Even with considerable flushing it is almost impossible to remove all of the cream from the bowl, hence there is always a loss in this respect which is proportionally large in the small skimmings. This is important in the selection of a separator.

- A. Obtain 30 or 40 pounds of milk and divide it into two equal parts. Skim one part at a temperature of 90° F. with the bowl running at normal speed. Skim the second part at a temperature of 90° F. with the bowl running at two-thirds of the normal speed. Follow instructions given in Exercise 8 for proper skimming.

Note: Shift the class so that every member has a new position.

| <b>Observations:</b>           | Machine..... | No..... | Capacity..... |
|--------------------------------|--------------|---------|---------------|
| (1) Weight of milk             | .            | .       | .             |
| (2) Test of milk               | .            | .       | .             |
| (3) Pounds of fat              | .            | .       | .             |
| (4) Pounds of cream            | .            | .       | .             |
| (5) Test of cream              | .            | .       | .             |
| (6) Pounds of fat in cream     | .            | .       | .             |
| (7) Pounds of skimmilk         | .            | .       | .             |
| (8) Test of skimmilk           | .            | .       | .             |
| (9) Pounds of fat in skimmilk  | .            | .       | .             |
| (10) Fat unaccounted for       | .            | .       | .             |
| (11) Per cent cream is of milk | .            | .       | .             |
| (12) Length of test in minutes | .            | .       | .             |
| (13) Capacity                  | .            | .       | .             |
| (14) Speed of bowl             | .            | .       | .             |
| (15) Temperature of milk       | .            | .       | .             |

**Conclusions:**

**Questions:** (1) Explain the principle of the cream screw.

(2) Why does the skimmilk screw operate in the opposite direction from the cream screw?

(3) What effect has the amount of flush water used on the test of the cream?

(4) What is the purpose of interior devices in the bowl, e. g., discs?

**References:** Jud. pp 180-192; St. pp 224-236.

EXERCISE NO. 11

**Object:** *To determine the effect of the richness of the milk on the efficiency of separation, on the relative quantity of cream and skimmilk, and the test.*

**Procedure:** Steadiness in running is one of the most important factors in efficiency of separation. Not only is there incomplete separation when a bowl vibrates, but there is danger in operating such a machine, since the bowl is likely to jump out and burst. The cause of a vibrating bowl may be a bent spindle, machine not level, changing covers of bowl, unbalanced bowl, unclean bowl, worn out bearings, dented bowl, machine not fastened down properly, excessive speed, bearings too tight, poor oil, or gummed bearing.

- A. Obtain 20 pounds of milk testing approximately 3%, and 20 pounds of milk testing approximately 4 or 5%. Skim each lot separately at a temperature of 90° F. with the separator at normal speed. Follow instructions given in Exercise 8.

Note: Students are to be shifted so that each one is in a new position.

| Observations: | Machine.....              | No.....   | Capacity..... |
|---------------|---------------------------|-----------|---------------|
| (1)           | Weight of milk            | . . . . . | .....         |
| (2)           | Test of milk              | . . . . . | .....         |
| (3)           | Pounds of fat             | . . . . . | .....         |
| (4)           | Pounds of cream           | . . . . . | .....         |
| (5)           | Test of cream             | . . . . . | .....         |
| (6)           | Pounds of fat in cream    | . . . . . | .....         |
| (7)           | Pounds of skimmilk        | . . . . . | .....         |
| (8)           | Test of skimmilk          | . . . . . | .....         |
| (9)           | Pounds of fat in skimmilk | . . . . . | .....         |
| (10)          | Fat unaccounted for       | . . . . . | .....         |
| (11)          | Per cent cream is of milk | . . . . . | .....         |
| (12)          | Length of test in minutes | . . . . . | .....         |
| (13)          | Capacity                  | . . . . . | .....         |
| (14)          | Speed of bowl             | . . . . . | .....         |
| (15)          | Temperature of milk       | . . . . . | .....         |

**Conclusions:**

- Questions:** (1) If we assume a loss of .04% of fat in the skimmilk and 250 pounds of cream are obtained from 2200 pounds of 3.5% milk, what is the test of the cream?
- (2) What is the loss in butter fat if the test of 2520 pounds of skimmilk is .17%?
- (3) How many pounds of cream are obtained from 2820 pounds of milk testing 3.6% fat if 85% of the whole milk is skimmilk testing .03%? What is the test of the cream?
- (4) Assuming that there are no losses in the skimmilk, how many pounds of 35% cream can be obtained from 450 pounds of 3.2% milk?

**References:** Jud. pp. 180–192; St. pp. 224–236.

EXERCISE NO. 12

**Object:** *To determine the effect of the rate of inflow into the bowl on the efficiency of separation, the relative amount of cream and skimmilk and on the test.*

**Procedure:** Some objections to farm separation of cream are made because the quality of farm skimmed cream suffers due to improper location of separator, infrequent washing, improper cooling of cream, and infrequent deliveries, and because of the extra time and power required to operate the separator.

- A. Obtain 30 or 40 pounds of milk and divide into two equal parts. Skim part one at a temperature of 90° F. with the separator running at normal speed, and the supply valve wide open. Skim the second part at 90° F. with the separator running at normal speed but with the supply valve only half open. Follow the directions given in Exercise 8.

Note: Shift the class so that each member fills a new position.

|                      |                           |           |               |
|----------------------|---------------------------|-----------|---------------|
| <b>Observations:</b> | Machine.....              | No.....   | Capacity..... |
| (1)                  | Weight of milk            | . . . . . | .....         |
| (2)                  | Test of milk              | . . . . . | .....         |
| (3)                  | Pounds of fat             | . . . . . | .....         |
| (4)                  | Pounds of cream           | . . . . . | .....         |
| (5)                  | Test of cream             | . . . . . | .....         |
| (6)                  | Pounds of fat in cream    | . . . . . | .....         |
| (7)                  | Pounds of skimmilk        | . . . . . | .....         |
| (8)                  | Test of skimmilk          | . . . . . | .....         |
| (9)                  | Pounds of fat in skimmilk | . . . . . | .....         |
| (10)                 | Fat unaccounted for       | . . . . . | .....         |
| (11)                 | Per cent cream is of milk | . . . . . | .....         |
| (12)                 | Length of test in minutes | . . . . . | .....         |
| (13)                 | Capacity                  | . . . . . | .....         |
| (14)                 | Speed of bowl             | . . . . . | .....         |
| (15)                 | Temperature of milk       | . . . . . | .....         |

Conclusions:

- Questions:** (1) What are the advantages of centrifugal separation to the farmer?
- (2) Give reasons for inefficient skimming of a separator.
  - (3) Where should a farm separator be located?
  - (4) How is the approximate length of time that the milk remains in the separator bowl calculated?

**References:** Jud. pp. 180–192; St. pp. 224–236.

## APPENDIX

Set of questions illustrating use of the tables in the appendix of Farrington & Woll.

1. How many pounds of fat are there in 17,839 pounds of milk testing 3.65%? In 4,327 pounds of milk testing 4.35%? (Table VIII.)
2. How many pounds of fat are there in 1,378 pounds of cream testing 29%? In 3,967 pounds of cream testing 47%? (Table VIII.)
3. If butter fat is worth  $24\frac{1}{2}$  cents per pound, what would 1,700 pounds be worth? (Table IX.)
4. If butter fat is worth 47c per pound, what would 900 pounds be worth? (Table IX.) Show method.
5. If butter fat is worth  $21\frac{1}{2}$  cents per pound, what would 729 pounds be worth? (Table IX.) Show method.
6. If butter fat is worth 35 cents per pound, what would 387 pounds be worth? (Table IX.) Show method.
7. How many pounds of butter may be expected from 19,837 pounds of milk testing 3.9%? From 43,756 pounds of milk testing 4.7%? (Table XI.)
8. If the per cent over-run is 19, how many pounds of butter may be obtained from 100 pounds of 4.7% milk? From 100 pounds of 3.9% milk? (Table XII.)
9. If the fat content of 100 pounds of milk is 3.9% and the lactometer reading is 33, what may be the yield of cheese? (Table XIII.)
10. How many pounds of cheese may be expected from 9,800 pounds of milk testing 3.7% fat and having a lactometer reading of 31? (Table XIII.)
11. How much do 15 gallons of 37% cream weigh? If a container would hold 97 pounds of water, how many pounds of 48% cream would it hold? (Table XVI.)
12. If a lactometer gave a reading of 31 at 57° F. what would be the correct reading? If the reading were 29 at 69° F. what would be the correct reading? (Table V.)
13. If a sample of milk testing 3.4% fat gave a lactometer reading of 31, what per cent solids not fat would it contain? If the test had been 5.5% and the lactometer reading 33, what per cent solids not fat would it contain? (Table VI.)
14. If the reading on the New York Board of Health Lactometer were 108, what would this equal on the Quevene? What would 29 equal on the N. Y. Board of Health? (Table III.)
15. What is the legal standard for cream in Oregon? In North Dakota? (Table II.)
16. What is the difference in composition between salted and unsalted butter? (Table I.)

TABLE I

Production of milk, and rank together with population and number of Dairy Cows<sup>1</sup>.

| State             | Population | Milk Prod.<br>Gals., 000<br>Omitted | Rank | No. of<br>Dairy<br>Cows | Pounds<br>Production<br>Per Cow |
|-------------------|------------|-------------------------------------|------|-------------------------|---------------------------------|
| Ala.....          | 2348174    | 93904                               | 26   | 394112                  | 1944                            |
| Ariz.....         | 334162     | 14371                               | 44   | 31619                   | 3724                            |
| Ark.....          | 1752204    | 87624                               | 29   | 415507                  | 1634                            |
| Cal.....          | 3426861    | 276424                              | 9    | 502415                  | 4610                            |
| Col.....          | 939629     | 79493                               | 30   | 192234                  | 2993                            |
| Conn.....         | 1380631    | 54894                               | 36   | 112622                  | 4128                            |
| Del.....          | 223003     | 11356                               | 47   | 33026                   | 2924                            |
| Dist. of Col..... | 437571     | 512                                 | 49   | 704                     | 6218                            |
| Fla.....          | 968470     | 12156                               | 22   | 71641                   | 1307                            |
| Ga.....           | 2895832    | 101616                              | 24   | 388448                  | 2124                            |
| Ida.....          | 431866     | 52365                               | 38   | 115336                  | 3560                            |
| Ill.....          | 6485280    | 370487                              | 7    | 957313                  | 3044                            |
| Ind.....          | 2930390    | 238794                              | 10   | 608211                  | 3044                            |
| Ia.....           | 2404021    | 361426                              | 8    | 897668                  | 2709                            |
| Kan.....          | 1769257    | 221454                              | 12   | 574257                  | 3311                            |
| Ky.....           | 2416630    | 146561                              | 15   | 441346                  | 2666                            |
| La.....           | 1798509    | 32973                               | 41   | 176936                  | 1324                            |
| Me.....           | 768014     | 77676                               | 31   | 175425                  | 3724                            |
| Md.....           | 1449661    | 58754                               | 35   | 161972                  | 3036                            |
| Mass.....         | 3852356    | 76316                               | 32   | 147331                  | 4352                            |
| Mich.....         | 3668412    | 382823                              | 6    | 802095                  | 3965                            |
| Minn.....         | 2387125    | 475507                              | 3    | 1229179                 | 3044                            |
| Miss.....         | 1790618    | 88192                               | 28   | 427406                  | 1591                            |
| Mo.....           | 3404055    | 228908                              | 11   | 661959                  | 2339                            |
| Mont.....         | 548889     | 51251                               | 39   | 127581                  | 2864                            |
| Neb.....          | 1296372    | 168083                              | 14   | 438459                  | 2528                            |
| Nev.....          | 77407      | 6312                                | 48   | 13349                   | 3854                            |
| N. H.....         | 443083     | 42556                               | 40   | 95997                   | 3689                            |
| N. J.....         | 3155900    | 70491                               | 34   | 130497                  | 3027                            |
| N. M.....         | 360350     | 12738                               | 45   | 37805                   | 2210                            |
| N. Y.....         | 10385227   | 756046                              | 2    | 1481918                 | 4317                            |
| N. C.....         | 2559123    | 95748                               | 25   | 290223                  | 2666                            |
| N. D.....         | 646872     | 138607                              | 17   | 370707                  | 2657                            |
| Ohio.....         | 5759394    | 396318                              | 5    | 888057                  | 3603                            |
| Okla.....         | 2028283    | 135821                              | 18   | 456332                  | 2012                            |
| Ore.....          | 783389     | 92845                               | 27   | 180462                  | 4136                            |
| Pa.....           | 8720017    | 421631                              | 4    | 885855                  | 3990                            |
| R. I.....         | 604397     | 12099                               | 46   | 21431                   | 4730                            |
| S. C.....         | 1683724    | 52955                               | 37   | 187846                  | 2348                            |
| S. D.....         | 636547     | 124428                              | 20   | 336892                  | 2339                            |
| Tenn.....         | 2337885    | 130286                              | 19   | 415128                  | 2494                            |
| Texas.....        | 4663228    | 202974                              | 13   | 833586                  | 1840                            |
| Utah.....         | 449396     | 29340                               | 42   | 66724                   | 3466                            |
| Vt.....           | 352428     | 122096                              | 21   | 290122                  | 3560                            |
| Va.....           | 2309187    | 110942                              | 23   | 357969                  | 2511                            |
| Wash.....         | 1353621    | 140525                              | 16   | 238270                  | 4911                            |
| W. Va.....        | 1463701    | 73690                               | 33   | 181206                  | 2984                            |
| Wis.....          | 2632067    | 858259                              | 1    | 1795122                 | 4016                            |
| Wyo.....          | 194402     | 14614                               | 43   | 34997                   | 2692                            |
| U. S.....         | 105710620  | 7805241                             |      | 19675297                |                                 |

<sup>1</sup> Pirtle.

TABLE II  
Production of Manufactured Dairy Products by States. <sup>(1)</sup>  
(000 omitted.)

| State          | Dairy<br>Butter <sup>2</sup> | Factory<br>Butter | Am.<br>Cheese | Swiss<br>Cheese | Brick<br>Cheese | All<br>Other<br>Cheese | Sweet<br>Cond.<br>Milk |
|----------------|------------------------------|-------------------|---------------|-----------------|-----------------|------------------------|------------------------|
| Ala.....       | 28,490                       | 831               | 51            |                 |                 | 7                      |                        |
| Ariz.....      | 593                          | 602               | 138           |                 |                 | 5                      |                        |
| Ark.....       | 25,571                       | 996               |               |                 |                 |                        |                        |
| Cal.....       | 5,758                        | 81,948            | 3,182         | 518             |                 | 1,584                  | 13,065                 |
| Col.....       | 5,776                        | 18,667            | 1,120         |                 | 22              | 162                    | 136                    |
| Conn.....      | 1,926                        | 754               |               |                 |                 |                        |                        |
| Del.....       | 895                          | 154               | 2             |                 |                 | 2                      | 353                    |
| Dist. Col. ... | 6                            | 10                |               |                 |                 | 44                     |                        |
| Fla.....       | 1,162                        | 99                |               |                 |                 |                        |                        |
| Ga.....        | 30,257                       | 1,868             | 3             |                 |                 |                        |                        |
| Ida.....       | 4,540                        | 9,883             | 5,311         | 1               | 4               |                        |                        |
| Ill.....       | 25,064                       | 51,393            | 3,275         | 859             | 585             | 4,600                  | 33,859                 |
| Ind.....       | 18,344                       | 51,541            | 78            | 12              | 37              | 224                    | 11,345                 |
| Ia.....        | 25,423                       | 151,486           | 361           |                 | 13              | 346                    | 1,272                  |
| Kan.....       | 17,456                       | 43,069            | 110           |                 |                 | 39                     | 1,620                  |
| Ky.....        | 34,080                       | 12,244            |               |                 |                 | 69                     |                        |
| La.....        | 4,252                        | 185               |               |                 |                 |                        |                        |
| Me.....        | 10,856                       | 402               |               |                 |                 | 20                     | 968                    |
| Md.....        | 6,163                        | 1,573             | 18            |                 |                 | 235                    | 1,019                  |
| Mass.....      | 2,019                        | 1,844             |               |                 |                 | 36                     | 86                     |
| Mich.....      | 25,775                       | 64,820            | 4,415         |                 | 415             | 3,332                  | 42,954                 |
| Minn.....      | 20,205                       | 200,340           | 7,252         | 19              | 202             | 615                    | 549                    |
| Miss.....      | 20,759                       | 5,715             |               |                 |                 |                        |                        |
| Mo.....        | 29,471                       | 52,642            | 224           |                 |                 | 1,440                  | 164                    |
| Mont.....      | 5,961                        | 10,667            | 662           |                 | 85              | 3                      |                        |
| Neb.....       | 13,761                       | 76,748            | 69            |                 |                 | 211                    | 44                     |
| Nev.....       | 266                          | 2,361             |               |                 |                 |                        |                        |
| N. H.....      | 3,240                        | 424               |               |                 |                 | 521                    | 82                     |
| N. J.....      | 1,600                        | 438               | 196           |                 |                 | 1,583                  | 934                    |
| N. M.....      | 1,404                        | 185               | 135           |                 |                 | 1                      |                        |
| N. Y.....      | 24,728                       | 19,264            | 38,497        | 1,590           | 1,351           | 22,264                 | 120,884                |
| N. C.....      | 25,552                       | 1,718             | 111           |                 |                 | 4                      |                        |
| N. D.....      | 14,413                       | 23,355            |               |                 |                 | 4                      |                        |
| Ohio.....      | 30,264                       | 79,198            | 128           | 2,864           | 92              | 2,539                  | 21,856                 |
| Okla.....      | 22,215                       | 14,065            |               |                 |                 |                        |                        |
| Ore.....       | 4,178                        | 18,128            | 7,688         | 4               | 121             | 29                     | 13,916                 |
| Pa.....        | 38,469                       | 13,186            |               | 411             |                 | 8,621                  | 25,430                 |
| R. I.....      | 175                          | 76                |               |                 |                 |                        |                        |
| S. C.....      | 13,846                       | 537               |               |                 |                 |                        |                        |
| S. D.....      | 10,267                       | 27,447            | 8             |                 |                 | 5                      |                        |
| Tenn.....      | 37,166                       | 11,463            | 284           |                 |                 |                        |                        |
| Teaxs.....     | 49,405                       | 10,956            |               |                 |                 | 71                     | 160                    |
| Utah.....      | 2,877                        | 7,500             | 2,139         |                 |                 | 47                     | 1,810                  |
| Vt.....        | 3,877                        | 1,940             | 1,506         |                 |                 | 566                    | 15,234                 |
| Va.....        | 25,477                       | 4,231             | 257           |                 |                 |                        | 20                     |
| Wash.....      | 5,900                        | 26,667            | 2,762         |                 | 83              | 1,846                  | 152                    |
| W. Va.....     | 17,715                       | 276               |               |                 |                 | 12                     |                        |
| Wis.....       | 8,666                        | 141,130           | 227,937       | 18,277          | 30,240          | 9,025                  | 37,985                 |
| Wyo.....       | 1,423                        | 1,894             | 1,791         |                 |                 | 13                     |                        |
| U. S.....      |                              | 1,256,920         | 312,286       | 24,555          | 33,250          | 60,133                 | 345,902                |

<sup>1</sup> Bureau of agricultural economics U. S. D. A., 1923.<sup>2</sup> 1920 census.

| Unsweet.<br>Cond.<br>Milk | Filled<br>Evap.<br>Milk | Pow-<br>dered<br>Milk | Cond.<br>Butter<br>Milk | Casein | Malted<br>Milk | Milk<br>Sugar | Ice<br>Cream | State      |
|---------------------------|-------------------------|-----------------------|-------------------------|--------|----------------|---------------|--------------|------------|
|                           |                         |                       |                         |        |                |               | 936          | Ala.       |
| 3,457                     |                         |                       |                         |        |                |               | 213          | Ariz.      |
|                           |                         |                       |                         |        |                |               | 703          | Ark.       |
| 100,180                   |                         | 10,788                | 5,928                   | 4,754  |                | 884           | 8,865        | Cal.       |
| 22,018                    |                         | 862                   | 292                     |        | 730            |               | 1,584        | Col.       |
|                           |                         |                       |                         | 3      |                |               | 3,032        | Conn.      |
| 3                         |                         |                       |                         | 134    |                |               | 549          | Del.       |
|                           |                         |                       |                         |        |                |               | 1,061        | Dist. Col. |
|                           |                         |                       |                         |        |                |               | 765          | Fla.       |
|                           |                         |                       |                         |        |                |               | 1,258        | Ga.        |
| 13,668                    |                         |                       |                         | 102    |                |               | 271          | Ida.       |
| 75,641                    | 745                     | 2,083                 | 5,331                   | 146    | 3,297          |               | 13,233       | Ill.       |
| 41,368                    | 1,217                   | 279                   | 2,852                   | 349    |                |               | 5,832        | Ind.       |
| 10,110                    |                         | 1,060                 | 8,339                   |        |                |               | 5,087        | Ia.        |
| 15,034                    |                         | 1,054                 | 3,559                   |        |                |               | 2,448        | Kan.       |
| 4                         |                         | 3                     | 3,085                   |        |                |               | 1,461        | Ky.        |
| 137                       |                         |                       |                         |        |                |               | 1,105        | La.        |
|                           |                         |                       |                         | 275    |                |               | 1,025        | Me.        |
| 13,652                    |                         | 382                   |                         |        |                |               | 3,590        | Md.        |
| 159                       |                         |                       |                         | 101    |                |               | 7,522        | Mass.      |
| 99,222                    | 4,117                   | 5,977                 | 2,945                   | 137    |                | 243           | 11,296       | Mich.      |
| 2,464                     |                         | 3,726                 | 305                     | 627    |                |               | 3,310        | Minn.      |
| 174                       |                         |                       |                         |        |                |               | 567          | Miss.      |
|                           |                         | 486                   | 1,885                   |        |                |               | 4,736        | Mo.        |
|                           |                         |                       |                         |        |                |               | 491          | Mont.      |
| 243                       |                         | 4,566                 | 4,998                   |        | 2              |               | 2,042        | Neb.       |
|                           |                         | 285                   |                         |        |                |               | 93           | Nev.       |
| 28                        |                         |                       |                         | 13     |                |               | 385          | N. H.      |
| 5,238                     |                         | 415                   |                         | 234    |                |               | 7,004        | N. J.      |
|                           |                         |                       |                         |        |                |               | 32           | N. M.      |
| 203,190                   |                         | 24,985                | 340                     | 2,490  | 128            | 916           | 20,527       | N. Y.      |
| 141                       |                         |                       |                         |        |                |               | 1,075        | N. C.      |
|                           |                         | 713                   | 200                     |        |                |               | 520          | N. D.      |
| 86,629                    |                         | 380                   | 11,420                  | 501    | 196            | 430           | 12,768       | Ohio       |
| 713                       |                         |                       | 533                     |        |                |               | 1,672        | Okla.      |
| 20,295                    |                         | 82                    | 45                      |        |                |               | 1,363        | Ore.       |
| 133,599                   | 110                     | 6,669                 |                         | 616    |                |               | 34,100       | Pa.        |
|                           |                         |                       |                         |        |                |               | 1,365        | R. I.      |
|                           |                         |                       |                         |        |                |               | 559          | S. C.      |
|                           |                         | 493                   | 1,422                   |        |                |               | 706          | S. D.      |
|                           |                         |                       |                         |        |                |               | 1,567        | Tenn.      |
| 22                        |                         |                       |                         |        |                |               | 3,665        | Texas      |
| 23,734                    |                         |                       |                         |        |                |               | 550          | Utah       |
| 4,870                     |                         |                       |                         | 936    |                | 399           | 282          | Vt.        |
| 877                       |                         |                       | 109                     | 20     |                |               | 1,759        | Va.        |
| 90,122                    | 856                     | 9,564                 | 269                     | 11     |                |               | 1,815        | Wash.      |
| 21                        |                         |                       |                         |        |                |               | 2,543        | W. Va.     |
| 461,966                   |                         | 7,319                 | 976                     | 3,063  | 10,978         |               | 5,892        | Wis.       |
|                           |                         |                       |                         |        |                |               | 188          | Wyo.       |
| 1,428,979                 | 7,045                   | 82,171                | 54,833                  | 14,548 | 15,331         | 2,872         | 183,412      | U. S.      |

TABLE III.

Utilization of Milk in the U. S. 1923 (Bureau of Agricultural Economics, U. S. D. A. 1923).

| Commodity                   | Pounds Whole Milk Used<br>000 Omitted | Unit Require-<br>ment | Pounds Manufac-<br>tured Produce<br>000 Omitted | Per cent of<br>Total Milk |
|-----------------------------|---------------------------------------|-----------------------|-------------------------------------------------|---------------------------|
| Creamery Butter.....        | 26,296,494                            | 21                    | 1,252,214                                       | 23.963                    |
| Farm Butter.....            | 12,810,000                            | 21                    | 610,000                                         | 11.673                    |
| Cheese.....                 | 3,989,470                             | 10                    | 1398,947                                        | 3.636                     |
| Condensed and Evap. Milk    | 4,437,203                             | 2.5                   | 1,774,881                                       | 4.044                     |
| Powdered Milk.....          | 52,480                                | 8                     | 6,560                                           | .048                      |
| Powdered Cream.....         | 6,232                                 | 19                    | 328                                             | .006                      |
| Malted Milk.....            | 33,728                                | 2.2                   | 15,331                                          | .031                      |
| Sterilized Milk (Cans)..... | 80                                    | 1                     | 80                                              | .....                     |
| Milk Chocolate.....         | 149,500                               | .....                 | .....                                           | .136                      |
| Ice Cream (Gals.).....      | 4,054,875                             | 13.75                 | 294,900                                         | 3.695                     |
| Total for Manufacturing.... | 51,830,062                            | .....                 | .....                                           | 47.232                    |
| Milk: Household Use.....    | 50,440,000                            | .....                 | <sup>3</sup> 53 gal.                            | 45.965                    |
| Fed to Calves.....          | 4,174,000                             | .....                 | <sup>4</sup> 200 lbs.                           | 3.803                     |
| Waste (estimated).....      | 3,292,000                             | .....                 | .....                                           | 3.000                     |
| Grand Total.....            | <sup>5</sup> 109,736,062              | .....                 | .....                                           | 100.000                   |

<sup>1</sup> Includes 4,250,000 pounds of farm made cheese.  
<sup>2</sup> Gallons.  
<sup>3</sup> Per capita consumption. Population estimated at 110,663,501.  
<sup>4</sup> Per calf. Calves estimated as 85 % of dairy cows.  
<sup>5</sup> Represents annual production of 24,552,000 cows, averaging 4,469.5 pounds of milk per cow.

TABLE IV.

Average Per Capita Consumption of Dairy Products Per Year.

| Country             | Gallons Milk | Pounds Butter | Pounds Cheese |
|---------------------|--------------|---------------|---------------|
| Argentina.....      | .....        | 18            | 3.7           |
| Australia.....      | .....        | 25.6          | 4.8           |
| Canada.....         | 26.0         | 27.7          | 3.0           |
| Denmark.....        | 68.5         | 19.0          | 12.3          |
| Germany.....        | 61.0         | 14.7          | 9.5           |
| Netherlands.....    | 39.5         | 16.8          | 13.3          |
| Sweden.....         | 69.7         | 16.5          | .....         |
| Switzerland.....    | 67.4         | 7.5           | 26.4          |
| United Kingdom..... | 22.2         | 17.0          | 11.2          |
| United States.....  | 43.0         | 15.5          | 4.2           |

TABLE V.

Production of Principal Dairy Products in Various Countries. (Pirtle and others.)

| Country             | Pounds<br>Butter | Pounds<br>Cheese | Pounds<br>Condensed |
|---------------------|------------------|------------------|---------------------|
| Argentina.....      | 56,722,973       | 49,893,528       | .....               |
| Australia.....      | 165,468,791      | 26,196,292       | 63,289,645          |
| Canada.....         | 236,691,718      | 149,201,856      | 92,104,562          |
| Denmark.....        | 257,484,000      | .....            | .....               |
| Germany.....        | 529,104,000      | .....            | .....               |
| Netherlands.....    | 95,900,100       | .....            | .....               |
| Sweden.....         | 62,135,000       | 17,603,731       | .....               |
| Switzerland.....    | 28,880,260       | 63,051,560       | 55,115,000          |
| United Kingdom..... | 282,056,320      | 89,541,760       | .....               |
| United States.....  | 1,862,214,000    | 398,947,000      | 1,774,881,000       |

TABLE VI.

Population, Number of Dairy Cows, and Milk Production of Various Countries.  
(Pirtle and others.)

| Country             | Population  | Dairy Cows | Yield<br>per Cow,<br>Lbs. | Gals. Milk<br>Produced<br>000 omitted <sup>2</sup> |
|---------------------|-------------|------------|---------------------------|----------------------------------------------------|
| Argentina.....      | 8,279,159   | 2,378,000  | .....                     | .....                                              |
| Australia.....      | 6,067,430   | 1,902,036  | 2,719                     | 621,900                                            |
| Canada.....         | 8,134,000   | 3,736,832  | 3,779                     | 1,697,000                                          |
| Denmark.....        | 2,940,979   | 1,184,268  | 5,666                     | 806,500                                            |
| France.....         | 41,475,523  | 6,544,460  | .....                     | .....                                              |
| Germany.....        | 55,086,000  | 8,222,753  | 4,350                     | 4,299,000                                          |
| Netherlands.....    | 6,778,699   | 1,232,264  | 7,585                     | 1,124,000                                          |
| Sweden.....         | 5,813,850   | 1,607,060  | 3,600                     | 695,300                                            |
| Switzerland.....    | 3,937,000   | 1,729,999  | 6,950                     | 3,609,800                                          |
| United Kingdom..... | 46,000,000  | 4,381,794  | 5,934                     | 3,126,000                                          |
| United States.....  | 105,710,620 | 19,675,297 | 3,627                     | 8,576,000                                          |

<sup>1</sup> 333,852 Goats additional.<sup>2</sup> Calculated on basis of milk yield per cow.<sup>3</sup> 2,640 gallons Goat's milk additional.

TABLE VII.  
Milk Solids and Water in Dairy Products.  
(Average of various authorities.)

| Product                        | Fat   | Protein | Sugar | Ash  | Water |
|--------------------------------|-------|---------|-------|------|-------|
| Whole Milk.....                | 3.7   | 3.2     | 5.0   | .7   | 87.4  |
| Skim Milk.....                 | .1    | 3.1     | 4.75  | .74  | 91.31 |
| Butter Milk.....               | .50   | 3.0     | 5.3   | .70  | 90.5  |
| Whey.....                      | .36   | .84     | 5.3   | .46  | 93.04 |
| Cream 20 %.....                | 20.0  | 3.0     | 4.2   | .60  | 72.20 |
| Cream 30 %.....                | 30.0  | 2.7     | 3.4   | .54  | 63.36 |
| Butter 80 %.....               | 80.0  | 1.0     |       |      | 16.0  |
| Cheese (American).....         | 33.83 | 23.72   |       | 5.6  | 36.84 |
| Condensed (Sweetened).....     | 11.03 | 10.14   | 14.98 | 2.12 | 25.29 |
| Condensed (Unsweetened).....   | 10.58 | 9.75    | 13.18 | 2.07 | 64.05 |
| Condensed Skimmilk (Sweetened) | .86   | 10.96   | 15.49 | 2.38 | 29.14 |
| Whole Milk Powder.....         | 28.20 | 26.67   | 47.88 | 5.75 | 1.50  |
| Skimmilk Powder.....           | 1.35  | 37.70   | 49.94 | 8.21 | 2.40  |
| Cream Powder (18 %).....       | 70.47 | 11.50   | 15.01 | 2.46 | .56   |
| Buttermilk Powder.....         | 8.00  | 34.00   | 40.00 | 9.50 | 2.50  |

TABLE VIII.  
Convenient Information

|                                     |                           |
|-------------------------------------|---------------------------|
|                                     | 9C                        |
| To convert Centigrade to Fahrenheit | $F = 32 + \frac{5}{9}C$   |
|                                     | 5                         |
|                                     | 9                         |
| To convert Fahrenheit to Centigrade | $C = \frac{5}{9}(F - 32)$ |
|                                     | 5                         |
|                                     | 9                         |
|                                     | 9R                        |
| To convert Reaumur to Fahrenheit    | $F = 32 + \frac{9}{4}R$   |
|                                     | 4                         |

|                           |                             |
|---------------------------|-----------------------------|
| 1 oz. Avoirdupois         | = 28.35 grams               |
| 1 gram                    | = .035 oz. Avoirdupois      |
| 1 pound Avoirdupois       | = .4536 kilograms           |
| 1 liquid quart            | = .9463 liter               |
| 1 liter                   | = 1.0567 quarts             |
| 1 gallon                  | = 3.7854 liters             |
| 1 liter                   | = .2642 gallons             |
| 1 inch                    | = 2.54 centimeters          |
| 1 centimeter              | = .3937 inch                |
| 1 foot                    | = .3048 meter               |
| 1 meter                   | = 3.2808 feet               |
| 1 gallon                  | = 231 cubic inches          |
| 1 cubic foot              | = 7.48 gallons              |
| 1 cubic foot of water     | = 62.5 pounds               |
| 1 gallon of water         | = 8.35 pounds               |
| Circumference of a circle | = 3.1416 × diameter         |
| Area of a circle          | = 3.1416 × square of radius |

TABLE IX.

## List of Popular Books and Magazines Relating to Dairy Manufacturing

## Books:

|                                              |                    |
|----------------------------------------------|--------------------|
| Testing Milk and Its Products.....           | Farrington & Woll  |
| Modern Methods of Testing Milk.....          | Van Slyke          |
| A Manual of Milk Products.....               | Stocking           |
| Principles of Dairying.....                  | Judkins            |
| Productive Dairying.....                     | Washburn           |
| Milk and its Products.....                   | Wing               |
| Farm Dairying.....                           | Larsen             |
| Market Milk.....                             | Kelley & Clement   |
| Principles and Practice of Buttermaking..... | McKay & Larsen     |
| The Book of Butter.....                      | Guthrie            |
| The Butter Industry.....                     | Hunziker           |
| Cheesemaking.....                            | Decker & Sammis    |
| The Book of Cheese.....                      | Thom & Fisk        |
| Manufacture of Ice Cream and Ices.....       | Frandsen & Markham |
| The Book of Ice Cream.....                   | Fisk               |
| Management of Dairy Plants.....              | Mortensen          |

## Periodicals:

|                                                    |                     |
|----------------------------------------------------|---------------------|
| Butter, Cheese and Egg Journal.....                | Milwaukee, Wis.     |
| Chicago Dairy Produce.....                         | Chicago, Ill.       |
| Creamery & Milk Plant Monthly.....                 | Chicago, Ill.       |
| Creamery Journal.....                              | Waterloo, Iowa      |
| Dairy Record.....                                  | St. Paul, Minn.     |
| Dairy World.....                                   | Chicago, Ill.       |
| Hoard's Dairyman.....                              | Fort Atkinson, Wis. |
| Ice Cream Trade Journal.....                       | New York, N. Y.     |
| Ice Cream Review.....                              | Milwaukee, Wis.     |
| Journal of Dairy Science.....                      | Baltimore, Md.      |
| Milk Dealer.....                                   | Milwaukee, Wis.     |
| New York Produce Review and American Creamery..... | New York, N. Y.     |
| Pacific Dairy Review.....                          | San Francisco, Cal. |
| Western Milk Dealer and Dairyman.....              | Seattle, Wash.      |





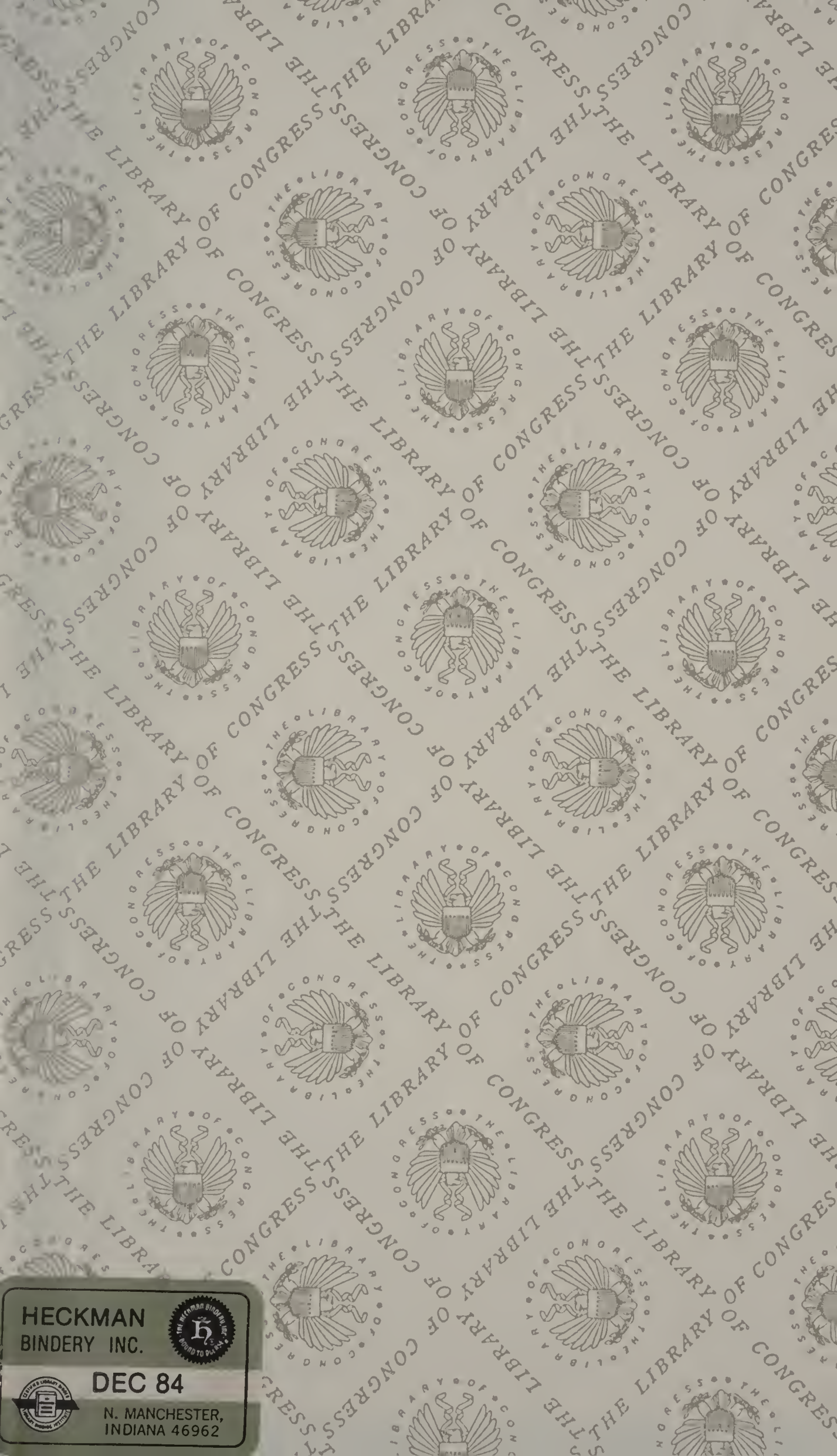












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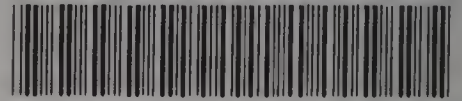


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